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Annual Report of the Department of Agriculture, 1936

VOLUME II

PLANT INDUSTRY

Part I.—Botanical Section

REPORT OF THE SENIOR PLANT PATHOLOGIST

Staff

The senior section of the staff were on duty throughout the year.

Mr. D. C. Edwards, Agricultural Officer in charge of Grassland Improvement, continued to be stationed at the Veterinary Research Laboratory, Kabete, while Mr. C. A. Thorold, Plant Pathologist, had his headquarters, as in the previous year, on Mount Elgon, where he was mainly engaged in investigations on Elgon dieback of coffee and, to a less extent, on coffee berry disease.

Mr. E. Cottington, Plant Inspector, was locally in charge of the Coffee Berry Disease Experiment Station, Sotik.

Mr. F. W. Evans, Junior Laboratory Assistant, carried out general laboratory work and was in charge of the central library at the Scott Agricultural Laboratories throughout the year.

Lectures, Shows, and Farmers' Days, etc.

Mr. Edwards addressed a meeting on the subject of grassland problems at Nanyuki in June, and dealt with similar matters as a member of a "mixed farming team" which visited Nakuru, Eldoret, and Kitale in November. He also arranged an exhibit of Rhodes grass (*Chloris gayana*) at the Nakuru Show in June, in order to emphasize the desirability of making use of this pasture type in a district to which it is well suited.

Mr. Thorold, in addition to attending a number of committee meetings of the Trans Nzoia Coffee Planters' Association, was also present at Coffee Field Days held under their

auspices at estates on Mount Elgon and at Turbo and Endebess, as well as at the Department's plots at Kitale. He also visited Nairobi in September, when he read a paper on "Elgon Dieback and Related Coffee Problems" at the Coffee Planters' Days.

I addressed planters' meetings on coffee diseases at Sotik, Songhor, and Nandi in January, and re-visited Sotik in August with the "mixed farming team" which then toured the district. I also staged a general exhibit of crop diseases at the Nakuru Show.

Plant Protection Services

In February I took over the administration of the plant protection services. This work deals with three principal matters, namely, the control of plant introductions, the health certification of plant exports, and the enforcement of those of the Diseases of Plants Prevention Rules which deal with the possible spread of diseases or pests through the neglect of individual farmers to take adequate measures for their control.

There is nothing of interest to report concerning the first two heads. Seven complaints were received during the year of neglected plantations, the crop grown being coffee in each case. In one instance inspection showed that no serious neglect had occurred, and the matter was dealt with without recourse to the issue of official instructions. In three other cases instructions were issued and satisfactory measures were taken by the occupiers.

At the end of the year action was still pending in three other instances. Difficulty was being experienced with one of these owing to the absence of the owners from the country. In another a notice had been issued but the time allowed had not expired. The third concerned a farm which had been purchased for addition to a native reserve.

Investigational Work

Mr. Edwards' report on his work on grassland improvement will, as usual, be submitted separately.

Coffee

Berry Disease

A full account of the investigational work on berry disease in 1936 is being published in the February (1937) number of the Monthly Bulletin of the Coffee Board of Kenya. A summary only will therefore be given here.

The main work was carried out at the Coffee Berry Disease Experiment Station, Sotik, where, unfortunately, the investigations and observations were considerably hampered by the effects of two hailstorms which occurred in February. During the second of these hailstones three-quarters of an inch in diameter were reported. These remained on the ground for eighteen hours, and the cold soil conditions which must have resulted were doubtless responsible for the severe berry fall which followed about a fortnight later. Principal attention continued to be given to varietal resistance studies and to vegetative propagation methods designed to discover resistant combinations of scion and root-stock suited to local conditions.

Plots of Mysore coffee raised from directly imported seed and of Amfillo, an Abyssinian variety, were added to the variety trial block, thus bringing the number of varieties and selections under observation up to thirteen.

A number of nursery grafts were planted out. These consisted in part of various combinations of scions from both susceptible and reputedly resistant varieties or individual bushes on *arabica* root-stocks of types, such as Blue Mountain, which are considered to be resistant. Several other nursery grafts with similar scions but on *robusta* root-stocks were also planted out. In several instances more than one type of head was grafted on the same root-stock, so that opportunity has thus been provided for accurate future observation of the root-stock influence, if any, on scions of different kinds on the same plant.

As previously reported, a block of coffee has been used for some time for experimentation with variously produced vegetative combinations between scions of different kinds and root-stocks consisting of suckers arising from the stumps, or of the actual stumps themselves, of old-established Mocha coffee which had been cut down to near ground level. During 1936 a plot was completed in which the scions used were of Kent's *arabica,* and seedlings of the Amfillo variety were planted in position preparatory to inarching. An odd row was also inarched with the indigenous *Coffea eugenioides.*

A small crop was borne in 1936 on those varieties which had been planted in 1933, and the opportunity was therefore taken of comparing the amounts of disease present in the different plots. None of the varieties was free from disease; even the Blue Mountain seedlings were affected to the extent of about four per cent, although observations made elsewhere in the past had shown that this variety is rarely infected.

There can be little doubt that the severe hailstorms had facilitated entry of the berry disease fungus, either through mechanical injury or by reducing the resistance of the bushes. Even under these exceptional circumstances, however, the Blue Mountain coffee was easily the least affected of those in bearing.

An experiment to test the effects of augmenting or depleting supplies of available nitrogen on the incidence of berry disease was concluded in 1936 after being in progress for four seasons. The nitrogen had been added in the form of farmyard manure at the rate of 45 tons per acre per annum on certain plots, while it had been depleted permanently or temporarily on others by removing successive crops of buckwheat or digging in grass at the rate of ten tons per annum respectively. The experiment was laid down as a latin square and, at the end of the four-year period, it was found that none of the treatments had had a significant influence on yield or degree of infection.

Three other chemical treatments were tested in further experiments. These were (1) the addition of nitrogen as sulphate of ammonia, (2) the application of zinc sulphate to the soil, and (3) the application of a comprehensive mixture consisting of potash, phosphate, artificial and organic nitrogen, and small quantities of eighteen "minor elements". In each of these experiments the average amount of infection in the treated plots was greater than that in the untreated control.

The effect of spraying with one per cent Bordeaux mixture according to two different schedules was tested on adjacent blocks of coffee on the single and multiple stem systems respectively. In each block there were six plots. Two of these were sprayed in January, May and July, two in March, May and July, and two were unsprayed controls.

The results were of the same order in both blocks, and considerably favoured the January, May and July spraying programme, although it must be borne in mind that the hailstorms in February occurred before the first spraying of the March, May and July programme was due to be applied, and may have had some influence on the incidence of the disease. Combining the figures for all the four plots of each treatment, the average degrees of infection found to occur were as follows:—

January, May and July sprayings ...	4.4%
March, May and July sprayings ...	11.5%
Controls, unsprayed	17.3%

Other work carried out included an experiment designed to demonstrate various ways of converting an old-established susceptible plantation into one of resistant type by interplanting or by means of vegetative propagation. An experiment was also begun to test the effect on the incidence of berry disease of forcing the bushes to enter a period of vegetative, non-cropping growth by severe cutting back.

The hailstorms so damaged the plots on which experiments were in progress on the effects of subsoiling, stripping a proportion of the crop, and damaging the roots, respectively, that no observations on them could be made during the year.

At the suggestion of the Songhor Farmers' Association about five hundred copies of a comprehensive questionnaire on coffee berry disease were printed and distributed to planters to the west of the Rift Valley. One hundred and seventy-six replies were received, and an analysis of these has been prepared for publication. No new information of outstanding importance came to light from the replies received, but a more accurate picture of the distribution and severity of berry disease was obtained than had previously been available. The answers to the questionnaires served to emphasize the connexion between low temperatures and the incidence of the disease, and there proved to be a sharp division of opinion, according to locality, as to which flowering produced the crop most liable to infection. The Trans Nzoia and Uasin Gishu coffee growers were practically unanimous in reporting that the "long rains" flowerings were worst affected, while the Sotik and Nandi planters were equally certain that the "short rains" flowerings suffered most.

The replies to the questionnaires dealing with the resistance of varieties and individual trees served principally to confirm previous views on the subject.

Elgon Dieback

The following are extracts from Mr. Thorold's report on his work on Elgon dieback and related subjects:—

"During the year I was able to confirm the previous observation that this disease occurs in various parts of the Colony. Typical cases of Elgon dieback were seen in farms at Sotik and Upper Kiambu. I have already indicated that Elgon dieback is little more than a particular form of 'hot and cold' disease. Consequently one can expect to find Elgon dieback, in at any rate a mild form, anywhere where coffee shows 'hot and cold' symptoms. The conditions producing

them both appear to be similar, but the severest form of 'hot and cold' occurs where the growth is continually stunted by the presence of unfavourable conditions throughout the year; whilst Elgon dieback appears to be the result of such conditions occurring only for brief periods and at certain times of the year; in the intervening periods the coffee is making 'normal' growth.

"The routine observations on Elgon dieback have been continued in the field, at Kapretwa. A large number of trees (over 300) are observed regularly every month and frequently at fortnightly intervals during the bad dieback periods. The observations, continued without interruption since December, 1934, now provide reliable data as to the relative resistance and susceptibility of this large sample of coffee trees.

"An attempt was made during the year towards associating the known variation in severity of Elgon dieback and the occurrence of particular climatic conditions. It was hoped that by noting the amount of dieback occurring every day on a large number of trees during a long period it might be possible to integrate Elgon dieback and climate. Accordingly a compact block consisting of 85 trees was taken, of which the behaviour towards Elgon dieback was already known. Commencing on the 7th of July, these trees were observed every day for forty days, and any Elgon dieback affected shoots were noted. Simultaneously over this period continuous temperature records were taken by means of a self-recording thermograph instrument. The number of Elgon dieback affected shoots noted each day varied between one and fourteen. Various brief spells of wet and fine weather occurred over this period and correspondingly large variations in diurnal temperatures. Maximum and minimum temperatures were obtained also with an ordinary thermometer. It suffices to state that it has not been found possible to correlate the more severe occurrences of dieback during this period with any particular set of conditions. It is considered that the lack of obvious correlation is to be attributed largely to the varying physiological status of the coffee trees and still more to this variability in the members of any one tree. Consequently a large number of shoots affected on any one day should be traced rather to those shoots being in a particularly susceptible condition rather than to the climatic conditions being particularly favourable for the occurrence of dieback in that period. This is a legitimate assumption since it is apparent that conditions occurring in the months of July and August are in general the worst for Elgon dieback.

"A certain amount of work has been carried out on the elucidation of the cause of dieback by attempting the production of the symptoms under controlled experimental conditions. The Senior Plant Pathologist has kindly carried out for me a series of experiments on the effect of low temperatures for varying periods on seedlings of a type known to be susceptible. These observations were made at the Scott Agricultural Laboratories, using a refrigerator installed there. Although certain pathological conditions were produced in the experimental seedlings, it cannot be said that these really resembled the symptoms of Elgon dieback.

"The coffee work and investigations carried out at Kapretwa during the year were mainly concerned with Elgon dieback and other directly related coffee problems. Berry disease was studied there to a limited extent, and mainly in so far as studies of the disease can be combined with and related to my other investigations on Elgon dieback. Many of the trees and types selected for resistance to one of these diseases in particular are tested also for reaction to the other.

"*Crop Recording on Individual Trees.*—The work of recording the yields of 116 coffee trees has now been carried out for three picking seasons, whilst an additional sixty trees have been recorded for two seasons. This is now providing a very valuable series of data from which important deductions can be made as to the behaviour and bearing capacities of coffee trees in general, and in particular regarding the unsuitable and undesirable types in this farm and district. This crop-recording functions both as a census study (that is, on a small but representative sample of larger population) and also as a critique of individual trees and types.

"*Liquoring Tests.*—The observations on individual trees have not been confined solely to quantitative recording of crop but samples have been examined for quality also.

"*Propagation.*—Considerable progress has been achieved in the propagation of selections made at Kapretwa Estate and in the neighbourhood. Both seeds and asexual methods of propagation have been resorted to in attempts to combine rapidity of multiplication with the minimum of variability from the selected type. It is fortunate from the horticultural point of view that the type of tree selected for resistance to Elgon dieback gives in its seedling progeny a considerable uniformity, at least in the vegetative characters in which resistance to Elgon dieback appears to be reflected. Consequently coffee farmers in the district concerned are now in

the possession of nurseries containing resistant-type seedlings grown from such trees.

"*Shade Trees.*—The study of shade trees suitable for the district has been continued and extended. One of the best appears to be an indigenous one, *Entada abyssinica* (local name *Musembe*). However, it is slow growing, but should be an excellent permanent shade tree. It should be established therefore in combination with a more temporary and quick-growing shade. Where shade is urgently required, either *Mororowet* (*Vernonia* sp.) or Castor can be used, the former being preferable. *Acrocarpus fraxinifolius* appears to be doing well in the district, but it does not provide much of a canopy.

"Plots of the following shade trees have been planted in an area of young coffee at Muroki Estate (Anderson Bros.): *Albizzia lophantha, Acrocarpus fraxinifolius, Entada abyssinica, Ficus* (two species), *Grevillea robusta, Macherium Tipu.*"

Grateful acknowledgment must be made to Mr. T. H. E. Jackson for his continued interest in the work and for the very valuable facilities provided for its execution; to Mr. R. S. Wollen and members of the staff of the Coffee Board, especially Mr. C. R. Devonshire, for great assistance with liquoring tests; to Messrs. H. B. Swann and J. F. Perkins for providing space and attention in their coffee nursery; and to Mr. J. W. Anderson for his assistance and co-operation in the work of planting and maintaining shade-tree plots.

Leaf Disease

A considerable number of greenhouse experiments have been carried out in an attempt to develop a technique for testing new coffee selections for their degree of resistance to leaf disease (*Hemileia vastatrix*). It cannot be claimed that a successful method, applicable at all times of the year, has yet been devised. The chief difficulty met with has been that of temperature, which has proved to be too low during several months of the year. On several days about July, even with all the windows closed and no overhead shade, it was found impossible here, practically on the equator, to attain a temperature of 70 degrees Fahrenheit inside the greenhouse!

In spite of the difficulties mentioned above, some interesting observations have been possible on various points. Some useful information has been obtained on the influence of comparatively low temperatures in prolonging the incubation period and reducing the severity of leaf disease. It has

been found also that Harar coffee is easier to infect than Mocha or any of the other varieties tested, and that leaves of the wild coffee, *Coffea eugenioides*, may remain practically symptomless, although infection has taken place and the presence of the fungus within the tissues has been readily demonstrable under the microscope.

The presence of pale yellow spots in coffee leaves in the plantation, particularly during the cooler months, is well known to many growers, many of whom regard them as being due to suppressed leaf disease infection. Experiments were carried out in 1936 with the object of testing this supposition, and attempts were made to develop leaf disease pustules on leaves showing the spots by subjecting them to greenhouse conditions under which it was known to be possible to obtain normal leaf disease pustules by artificial inoculation with the causal fungus. All such attempts failed completely. Microscopic examination of a number of a number of typical yellow spots also failed to disclose the presence of any trace of the fungus within the tissues, although it was very easy to find in sections made through normal leaf disease spots. No other organism was found within the yellow spots, so that the evidence at the moment is that they are not due to leaf disease or to any other parasitic infection.

Wheat

Stem Rust (Puccinia graminis)

In the course of testing a sample of stem rust from the variety 58.F.(L.1), grown under irrigation at Timau, a single pustule of semi-susceptible type developed on an artificially inoculated seedling of this variety. As it seemed possible that a new physiologic form of the rust might be present, supplies were multiplied from the single pustule until enough was available to carry out routine identity tests. On all the twelve wheat varieties normally used for the purpose the rust thus obtained gave the reactions for Form K4, but with rather greater virulence. A similar result was obtained when tests were made on a large range of locally bred wheats whose reaction to K4 was already known. Varieties which had been found highly resistant to K4 were only moderately resistant to the new strain, while some which had previously shown modern resistance to the former showed only slight resistance or were even slightly susceptible to the latter. From the scientific point of view, the new rust is to be regarded as a somewhat more virulent strain of Form K4 rather than as an entirely new form.

As usual, a large number of tests were carried out for the Plant Breeding Section to determine the reaction of new hybrid selections to the various forms.

In addition, thirty-five samples of rust from different parts of Kenya were tested to identify the form present. All four forms were found to occur in one district or another, and in seven instances two were shown to occur simultaneously in the same rust sample. Forms K2 and K4 were again the most prevalent. The following list shows the distribution of the four forms during the year. Where more than one test from the same area was made in a single month, the number of such tests is given in brackets:—

K1—

Eldoret: September.

Kinangop: October.

K2—

Nairobi: September.

Njoro: August, October (2), November, December.

Eldama Ravine: October (3).

Molo: December.

Mau Summit: November.

Burnt Forest: September, October.

Lessos: October.

Eldoret: September.

Mount Elgon: October.

K3—

Njoro: June.

Rongai: July (2), September.

Eldama Ravine: October.

Lessos: October.

K4—

Nairobi: September.

Kinangop: January.

Njoro: June, August.

Rongai: July (2), September.

Eldama Ravine: October.

Molo: December.

Burnt Forest: September.

Eldoret: September.

Form K4 was also identified on a single sample of Kenya Standard wheat from Iringa, Tanganyika Territory, in August.

The routine tests were almost entirely carried out by Mr. F. W. Evans, who performed the work very satisfactorily.

Leaf Rust (P. triticina) *and Yellow Rust* (P. glumarum)

As in 1935, Mr. Thorold planted test varieties of wheat in a bird-proof cage at 11,000 feet on Mount Elgon, to observe what rusts were present at that high altitude. No rust occurred there in 1935, but in 1936 both leaf and yellow rust appeared to a slight extent. Black Chaff disease (*Bacterium translucens* var. *undulosum*) was also present to some extent on a few plants.

Take-all Disease (Ophiobolus graminis)

The plot at Molo, from which it is hoped eventually to be able to discover which of certain indigenous and exotic grasses is the host of the take-all fungus, has been maintained by Mr. R. S. Ball, Agricultural Officer, Njoro.

Granadilla

A destructive disease of this crop, occurring on a single estate in the Trans Nzoia district, was investigated by Mr. Thorold, who found that the trouble occurred as a collar rot with lesions on the stem, leading to unhealthy growth and malformation and loss of fruits. A fungus, which has not yet been definitely identified, was found associated with the disease, but appeared to be doubtfully parasitic. The disease occurs with wet and cold conditions during the rains, and the plants recover rapidly on the return of dry weather. Temporary measures, consisting of removing the soil from the base of the plant, allowing good air circulation in the collar region, cutting away the lesions and applying Bordeaux paste, had been instituted with some success by the manager.

Flax

Rust (*Melampsora lini*) occurred in varying intensity in crops of Liral Crown grown at Nakuru and Kitale during the year. In certain instances the damage to the fibre was rather severe, but there was little apparent reduction in yield of seed. At the moment seed production for export is fortunately the main object in growing the crop, but remedial measures may have to be given attention if fibre production is seriously undertaken.

Cotton

Wilt on a small scale was reported from the Coast, and has been under investigation. *Fusarium* strains have been isolated from diseased plants and are being tested for pathogenicity.

NEW PLANT DISEASE RECORDS

The list of new records for 1936 is as follows:—

Sugar Cane.—Rind disease, *Melanconium sacchari* (Cke.) Mass.

Flax.—Rust, *Melampsora lini* (Lk.) Desm.

Peach.—Splitting disease, believed due to *Armillaria mellea* (Vahl.) Fr., but fructification not seen.

Field Pea.—Powdery mildew, *Erysiphe Polygoni* D. C.; Downy mildew, *Peronospora Vicieae* Berk.; Leaf blight, *Ascochyta Pisi* West.

Cowpea.—Powdery mildew, *Erysiphe Polygoni* D. C.

Napier Grass (*Pennisetum purpureum*).—On leaves, *Beniowskia sphaeroidea* (Kalchbr. & Cooke) Mason.

Foxtail Millet (*Setaria italica*).—Smut, *Ustilago Crameri* Koern.

Granadilla (*Passiflora edulis*).—Woodiness; virus.

Rose.—Rust, *Phragmidium disciflorum* James.

Phlox Drummondi.—Leaf spot, *Septoria Drummondi* Ell. & Ev.

Barberton Daisy (*Gerbera Jamesoni*).—Rust, *Aecidium crypticum* Kalchbr. & Cke. (tentative).

The fungus, *Cicinnobolus cesatii* de Bary, was found parasitizing the cucurbit mildew, *Erysiphe cichoracearum* D. C.

Coffee berry disease (*Colletotrichum coffeanum* Noack), well known for several years on other varieties of *arabica* coffee, was recorded for the first time on the Harar variety, an introduction from Abyssinia.

ACKNOWLEDGMENTS

I desire to acknowledge the valuable assistance which I have received as usual from the Directors and Staffs of the Royal Botanic Gardens and the Imperial Mycological Institute, Kew.

J. McDONALD,
Senior Plant Pathologist.

REPORT OF THE AGRICULTURAL OFFICER IN CHARGE OF GRASSLAND IMPROVEMENT

Work has continued on the lines indicated in the 1935 Report and, in addition, a considerable amount of survey work was undertaken during the year, mainly in connexion with a development scheme for the Masai Reserve.

Progress of Experimental Work

The relationship of the experimental work at various centres to the regions of different climatic conditions was explained in the 1935 Report.

Kabete

Work at this centre bears on the grassland problems of the areas of high altitude and those of intermediate conditions.

A considerable number of species, both indigenous and introduced, has been added to those which have undergone preliminary trials on a small scale, and a few further species have been carried to the stage of field establishment.

The experiments mentioned for this centre in the previous report have been continued, but are for the most part not yet completed. The work was started in 1934, and a considerable part of the time has been taken up by the establishment of the plots.

Items which should be mentioned in connexion with the year's work on these experiments are as under:—

Pennisetum clandestinum (*Kikuyu Grass*) *Strains.*

Material obtained from a number of isolated climatic areas in which this group occurs has been found to fall into three groups, and an experiment is in progress to compare the behaviour of the three types under a system of cuts. Differences in seasonal yields and in ability to withstand the cutting treatment are becoming evident, but the most striking difference so far recorded is in the flowering habit, which clearly distinguishes one type from the other two.

Trifolium Johnstonii (*Indigenous Clover*) *Strains*

This clover occurs naturally in the herbage of the Kikuyu grass areas, and under grazing conditions is usually an important constituent of the pastures. One of its chief drawbaks is the tendency to dry off after a short period of growth.

A preliminary comparison of three types obtained locally appears to show that one of these (the most common) is subject to a virus disease which causes premature withering of the leaves.

Chloris gayana (Rhodes Grass) Strains

Work on the strains of this grass has continued. Three clearly different types are under experiment, and in addition material obtained from Uganda and Nyanza has shown distinct behaviour in preliminary trials. The evidence so far available indicates that the Australian strain of this grass is superior for use over a wide range of conditions in Kenya. This type is of African origin, and is produced in Queensland.

Fodder Crop Experiment

This experiment, which is intended to produce information as to the most suitable crops for storage to supplement the grazing in times of scarcity, has already given results of value. *Pennisetum purpureum* has proved to be by far the heaviest yielder, while maize is capable of producing a crop most rapidly, starting from arable land, of the six types under experiment.

Other Legumes

The search for pasture and hay legumes for use in mixture with the grasses for the areas of the country under intermediate conditions has, unfortunately, produced little advance during the year. A number of new types have been tested but have not been considered worthy of more than the preliminary small-scale trials. Several other types which have been tried in mixture with grasses have had to be discarded. Lucerne, although it cannot be said to be satisfactory, is the best type at present available for sowing with the grasses for hay and pasture. *Indigofera tettensis*, an indigenous legume, continues to give promising results, but, owing to an exceptional season, seed production was greatly reduced.

Lucerne Selection

With a view to the production of an adapted type of lucerne, selection has been carried out for the past two years. The original material consisted of plants found persisting in pasture established on the sites of old lucerne areas. It is believed that some advance has been made, and during the year a promising line has been multiplied.

Experiments at Ngong Animal Husbandry Centre

This work, which consists of an investigation into the effects of grass burning and of different intensities of grazing on the natural herbage and trials of pasture and fodder plants, has been continued. It would appear that over a period of from three to four years no very marked effects have been produced under the conditions at this centre by either the burning or grazing treatments.

Work at the Experimental Station, Naivasha

The experiments at this centre bear on the problems of some of the drier areas of the country. They consist of pasture and fodder plant trials, a manurial experiment, and work designed to investigate the possibilities of renovating depleted pasture by the use of sown species of grasses and legumes and various surface treatments of the soil.

There is little to report in addition to the information contained in the 1935 Annual Report. Further unsuccessful attempts have been made to establish certain of the species under the erratic rainfall conditions of the district. The Australian strain of Rhodes grass has continued to give some promise for hay production in the area.

Rhodes Grass Trials

During the year the use of this grass has been extended very considerably in the settled areas of the country. In the areas of intermediate climatic conditions it appears that it will go far to supply the need for a pasture type for sowing down on disused arable land in both European and native farming. It has recently been reported successful from Maseno, a centre in the lower, moist conditions of the Nyanza Province, where it may also prove to be of value in the sowing of abandoned areas of native cultivation and in the development of the native smallholding scheme.

The grass has become so far established in the farming of the country that there is now a supply of locally produced seed available on the market.

The problem, mentioned in the previous report, of providing legumes for use in mixture with this grass is not yet much nearer to solution. Lucerne is of some value for the purpose, and further experiments may show that *Indigofera tettensis* can be used successfully, but sufficient material of this plant for large-scale trials has not yet been obtained.

Survey Work

A considerable amount of time in the latter half of the year was devoted to a preliminary ecological survey of the Masai Reserve, mainly with a view to obtaining information necessary to a scheme of development which has been put forward. A rapid survey of the Yatta Plateau was also undertaken in order to make recommendations for the application of a scheme for the control of grazing, with a view to preventing the further deterioration of this area, which is being used to accommodate the cattle removed from the badly eroded parts of the Ukamba Reserve. The survey of the Masai Reserve is fully reported upon in my memoranda, "The Grasslands of the Western Masai Area" and "The Grasslands of the Eastern Masai Area."

The western half of the reserve lies mainly at altitudes of 6,000 feet or above. The moisture conditions are correspondingly high, and there is considerable scope for development.

There are two main climatic types of area to be considered: one under comparatively high rainfall and characterized by forest and a park-like vegetation, which consists of forest reduced by periodical fires; and the other consisting mainly of open grassland under drier conditions and subject to drought. Both types are of considerable extent, the former including the Mau Escarpment, the Trans Mara area and the Loita Hills, and the latter the Loita Plains, the Lemek Valley and the Kedong Valley. In addition to these main types, there is a considerable area of dry thorn bush or acacia-desert grass savanna to the south of the western section of the reserve.

Under present conditions the two main types appear to be utilized seasonally by means of migrations, principally from the Mau Escarpment to the Loita Plains and Lemek Valley for the wet seasons and return for the dry seasons.

On the whole, this portion of the reserve would appear to be lightly stocked, and the mode of utilization practised in the past has led to no extensive deterioration of the vegetation. It is believed that a very considerably greater number of stock could be carried if the two main types of area could be utilized separately, and, at the same time, a more settled mode of living developed in the Masai. From the evidence obtained it would appear that, apart from any natural liking which this tribe may have for nomadic habits, there are two main factors which make seasonal movements a necessity.

These are (*a*) an unsatisfactory distribution of permanent water supplies in the open grass plains, which limits the use of these areas practically to the rainy seasons, and (*b*) mineral deficiency of the soil in the higher-altitude moist areas, which appears to be the cause of movement to the salt-licks of the plains. Before the Masai can be developed and the region under consideration fully utilized it will be necessary to remove these two underlying causes of migration.

The general impression obtained from the tour of this western half of the Masai Reserve was one of the considerable possibilities of development. Throughout there was no sign of deterioration of extensive areas from overstocking, as has already been remarked, and it should be noted that this conclusion was reached, not from the quantity of grazing available after what had been a year of exceptionally good rainfall, but from the nature of the species of which the herbage is composed and of the vegetation in general.

The type of development which is visualized is that of pastoral holdings in the higher moisture areas and extensive control of grazing in the drier plains, at first on a communal basis and later developing towards individual or family holdings as the distribution of water supplied is improved. The introduction of more settled ways of living will, of necessity, entail the development of some measure of arable agriculture, for the production of reserve fodder for use in dry periods, and eventually of food crops. There is evidence alrady of some movement in the direction of crop cultivation, as the growing of maize on disused *manyattas* (herding places) was not infrequently encountered.

It should be realized that there may be dangers attendant upon the development of arable agriculture, and these should be taken into account from the outset. Although the Masai have reduced the forest over portions of the higher moisture areas by the use of fire, they have not indulged in the wholesale clearing which is so commonly the case in areas occupied by agricultural tribes. Further, there is not yet a great number of goats in this part of the reserve, and the comparative scarcity of these animals probably accounts in on small measure for the retention of much of the tree vegetation.

The eastern half of the Masai Reserve is very differently situated with regard to moisture conditions, and, in general, it lies at lower altitudes. By far the most extensive type of vegetation is the dry acacia-desert grass savanna, with which may

be grouped the closely similar desert grass areas. The moister types, consisting of tall grass and acacia-tall grass savanna, are of very limited extent.

The whole of this portion of the reserve is subject to very light grazing on a nomadic basis. Even in the limited moister areas the distribution of permanent water is such that only temporary occupation is possible. Consequently, in these better areas, the ample supply of herbage which occurs seasonally is frequently left largely unconsumed. No signs of severe overgrazing were encountered except in the vicinity of water supplies, and soil erosion is as yet unimportant.

The whole question of improvement turns on the possibility of bettering the distribution of water supplies, but it must be realized that the main part of this eastern half of the reserve supports a climatic type of vegetation which is of very low productive capacity. Although an improvement in watering facilities may make it possible to increase the number of stock within this type, it is believed that the increase cannot be very substantial.

In any scheme of development which may be contemplated, it is suggested that attention should first be concentrated on the fuller utilization of the moister areas falling within the tall grass and acacia-tall grass savanna. The first step necessary appears to be the improvement of distribution of water by the provision of permanent supplies such as boreholes in these areas, after which the improvement may be carried on the better portions of the drier types of vegetation adjacent in the form of more temporary water supplies for wet season use. The better vegetational areas would then be used in the dry season and movement into the dry districts would take place for the period of the rains. In this way, by means of controlled migration, the limited moister portions of this section of the reserve would form centres from which development would be extended to the adjacent parts of the extensive dry areas. It is considered that the water supplies provided for the dry type of area should be essentially in the form of many temporary supplies, such as dams, rather than a few permanent ones, in order to encourage even distribution of grazing. The production and storage of hay in the moister areas may be found to be a necessary step.

It will be seen that the problem of development in the eastern section, or Kajiado division, of the Masai Reserve is a very different matter from that of the western section, or

Narok division. Although a considerable measure of improvement can be attained if the distribution of water supplies can be augmented on the lines indicated, the view is held that the Masai in this eastern section of the reserve are living under climatic conditions which, over the greater part of the area, preclude the possibility of advance to a settled mode of living.

Lectures, Demonstrations, etc.

Lectures dealing with the grassland problems of the districts concerned were given to farmers during the year at Nanyuki, Nakuru, Kitale, and Eldoret. An exhibit dealing with the work on Rhodes grass strains was staged at the Agricultural Show at Nakuru.

Herbarium

A considerable amount of collecting was undertaken in connexion with the survey work carried out, and it is desired to acknowledge the valuable assistance received from the Royal Botanic Gardens, Kew, in the identification of pasture species.

D. C. EDWARDS,

Agricultural Officer in Charge of Grassland Improvement.

Part II.—Plant Breeding Section

REPORT OF THE PLANT BREEDER

Staff

Mr. R. J. Lathbury, Plant Breeder, was absent from the Station on home leave from 4-1-36 to 26-7-36.

The Plant Breeder completed the threshing of the 1935 wheat crop before his departure, when Mr. G. J. L. Burton, the Senior Plant Breeder and Experimentalist, was stationed at Njoro until his departure on home leave on 2-5-36. During this period he dealt with all the issues of new wheats and the 1936 sowings.

The Plant Breeder's return in July enabled him personally to harvest all the sowings.

As the result of the implementation of the Pim Report, the Senior Plant Breeder and Experimentalist on his return from leave was transferred to the coffee services, and the Plant Breeding Services are therefore left with one Plant Breeder only. Under these conditions the maintenance of continuity in the future would appear to be a matter of some difficulty.

Mr. R. S. Ball, the Agricultural Officer, and Mr. R. N. Noble, the Junior Laboratory Assistant, were on duty at Njoro for the whole year.

During the period between the Senior Plant Breeder's departure and the return of the Plant Breeder, Mr. Ball assumed charge of the Station, and thanks are in particular due to him for the large volume of extra work which he undertook during that period.

Wheat—General

An increase in the acreage seeded to wheat has to be recorded in 1936. This is due partly to the issue of new departmental wheats and partly to the low prices, particularly for maize, at the time. Wheat has therefore replaced maize to an appreciable extent in the maize-growing districts of the Rift Valley, where the increase in the wheat acreage is approximately fifty per cent. The total acreage under wheat in 1936 is estimated at 55,000 acres.

The unusual rains experienced in the early part of the year interfered with the late harvesting of the 1935 crop and with the preparation of the land for the new crop, but on the

whole a fair growing season was experienced, and the wheat was generally reaped under favourable conditions.

Rust was responsible for a varying amount of damage, Form K2 being present all over the country, whilst Form K4 was more local in appearance, the reverse of last year. A very bad infection of leaf rust was experienced.

6,000 bags of strains of Cross No. 112 were issued. Other varieties sown were Sabanero, Kenya Governor, and, to a smaller extent, B.256.G., Equator, and Burbank. Wheat No. N.B.230 was almost entirely replaced by No. 112 at the high altitudes.

Sabanero again showed itself fairly rust-resistant, and its ability to grow well on the poorer type of soil is a big advantage. Owing to its poor milling qualities, it was necessary to curtail the acreage sown to this variety.

The estimated yield is approximately 3½ bags per acre and the grade higher than normal.

Physiologic Forms of Stem Rust

At the beginning of the year some rust was reported on wheat No. 58.F.(L.1), growing under irrigation beyond Timau, near the Isiolo Escarpment. Investigation showed that there was a fair infection of rust on the lower parts of the stem, whereas the stems of Sabanero, growing alongside, had rusted all the way up. The rust was handed over to the Botanical Section, and results showed that whilst the bulk of the rust was Form K4, one spore of another unknown form was also present.

All the new hybrid wheats have undergone seedling inoculation tests with this unknown form, which was multiplied up for this purpose, and the majority show a 2 verging 3 reading, i.e. slight susceptibility. Wheat No. 58.F.(L.1), which shows complete resistance to the four known forms in seedling inoculation tests, also gave a 2 verging 3 reading to the new form. On the other hand, wheats susceptible to Form K4 showed complete susceptibility to this unknown form, i.e. a 4 reading, and the American differentials gave reactions similar to Form K4 reactions. It would appear therefore that wheat No. 58.F.(L.1) is itself a differential to the new form. It is probable that this original spore was a mutation arising from K4. No further case has been identified, and precautions were taken that the rust which was increased for purposes of inoculation should not be disseminated. It is now to be destroyed.

Rust was also found on 58.F.(L.1) at the end of this season in two cases out of some sixty where the wheat was growing. Though only very slight damage was caused, the rust was examined and found to be Form K2. In each case this rust was found to be epidemic on the farm, and it would seem that a wheat highly resistant to Form K2 in the laboratory could rust to some extent in the field under severe epidemic conditions.

Form K4, which was present throughout the country in 1935, was epidemic to a less extent this year, and its distribution, whilst fairly general, was very uneven and patchy. A susceptible wheat would be found badly infected in one place, whereas a short distance away the same variety would be found to have a slight infection only.

Form K2 was generally present, and Cross No. 112 was badly damaged in some cases at the lower altitudes. The fact that, when a wheat susceptible to all forms but one is grown, the one form to which it is not resistant invariably appears, can be partly explained on the assumption that the variety susceptible to this one form is sown over bigh areas and acts as a host to the form, and so assists in its spread and multiplication. This is instanced by the spread of K2 on Cross No. 112 this year and by the spread of K4 on Kenya Governor and N.B. 230 last year.

The stem rust studies in co-operation with farmers have again proved their value. Form K2 was found in 18 cases and Form K4 in 16 cases, though, in some of the latter, infection was very slight. Form K3 was found at Timau and Eldama Ravine, whilst Form K1 was only present in one case at Eldoret. In ten cases Forms K2 and K4 were both present on the same farm; in one case Forms K1, K2 and K4 were all present together, whilst in another case Forms K2, K3 and K4 were together. Growers of these tester wheats are thanked for their co-operation, which is greatly appreciated.

As a general observation, it would seem that K2 is not epidemic until the second half of the season. There is, unfortunately, no close season for wheat in Kenya, as planting takes place according to locality from February to October, and between October and February wheat is sometimes sown under irrigation. Growers are, however, recommended to eradicate all volunteer wheat as being one source of checking stem rust.

Wheat Breeding at the Plant Breeding Station, Njoro

A good growing season was experienced except for a dry spell in July.

As in 1935 an artificial rust epidemic, embracing all four forms, was created. The early method of applying a spore suspension to the leaves was not successful, but the later injection method, whereby the spore suspension was injected into the top internode of the culm, proved satisfactory and a good "take" was obtained. Form K4 was present naturally, and later Form K2 appeared, but it was not severe on the station as in the neighbourhood.

Whilst these surrounds inoculated with the various forms of stem rust assist very considerably in exposing the hybrids to rust infection, it is felt that the amount of infected material is not always sufficiently great to cause a hundred per cent infection unless conditions for the spread of the rust are very favourable. It is possible therefore that plants which actually only escape rust may be considered as resistant.

Isolated blocks of pure line hybrids were also grown, and their surrounds infected with Forms K1, K2, K3 and K4 respectively. The block inoculated with K2 and K3 took well, the K4 block moderately, and the K1 block failed. These blocks are of value as being an additional test of a wheat's resistance to rust.

Yellow rust and orange leaf rust were both very severe this season.

Cross No. 112, *Njoro Hybrid x English Hybrid from Cambridge*

Issues of 6,000 bags of various strains of this cross were made at the beginning of the year. Some of these strains were for temporary use only until sufficient seed of the better strains was available. This wheat was primarily bred for the higher altitudes, but owing to its resistance to Form K4 it was also grown at the lower altitudes of 7,000 to 6,000 feet, although it was not recommended for these heights.

Under this large-scale test throughout the country its behaviour has been mixed, and the following points have emerged: It requires good land and does not suit the poorer types of soil. It is very susceptible to leaf rust, particularly at the lower altitudes. It can rust badly with Form K2 at the lower altitudes, as was expected, though it has not suffered

to any extent from this rust at the higher altitudes. Where conditions have been suitable good yields have been obtained.

It is therefore obviously a wheat for the high districts. Two strains have been earmarked for continuing with as being better milling wheats. These are No. 500 (112.B.11.(L.1)) and No. 503 (112.E.8.(L)). The latter wheat, No. 503, would appear to be less susceptible to stem rust. A white-grained strain out of this wheat is in the course of being multiplied up, as it is a still better milling wheat and still less susceptible to stem rust.

Cross No. 58, *Red Egyptian x Kabete Hybrid* (B.F4.3.B.10 V.1.(L))

Some 100 bags were issued to seventy growers this year, and growers who received small amounts were advised to cut out alternate rows in their drills so that the wheat would be drilled at about 16 inches between rows, which would allow a hand weeding between the rows. Excellent yields were harvested in many cases by this method, forty to fifty fold increases being obtained. One or two big growers utilized two seasons in the year for multiplication, and 3,000 bags of seed should be available for sowing in 1937.

The wheat is only suited to the lower altitudes, as it is susceptible to yellow rust. It is an excellent yielder, though inclined to lodge on rich land. Tests to date show it to be a moderate milling wheat, and the mills will take all the 1937 crop, when large-scale tests will be enabled to be carried out.

Seedling inoculation tests show it to be highly resistant to all four forms of stem rust, and whilst, as has been mentioned earlier on, rust was present on three occasions, it is not felt that this is likely to be serious, and it is certainly as resistant as any wheat growing in the country. The grain harvested has been first grade in many cases.

Cross Nos. 117 *and* 122, *Nporo Hybrids x Marquis*

These are suited to the 7,000 ft. level, and have been grown on again by farmers this year. They have shown themselves to be susceptible to Form K2 of stem rust, though resistant to the other three forms. Like Cross No. 112, they are very susceptible to leaf rust. They are medium to medium slow maturing, and they are worth growing on in those areas where they have done well, if only for their grain quality, which is excellent.

One strain of a later generation shows resistance to Form K2, and this is coupled with a medium early maturity and a high yielding capacity. This wheat has now reached the bag stage.

Crosses Nos. 130 *and* 131, *Njoro Hybrid x Australian Florence Selections*

Four strains which have reached the bag stage were issued and have been grown by farmers. It will be recollected that whilst these wheats were resistant to Forms K3 and K4 of stem rust, some doubt was felt about their resistance to K2 in the field. This doubt was justified in the case of one strain, which has shown susceptibility to K2 at two centres, though in neither case was any material damage done. One other strain showed slight rust, though the wheat adjacent to it had rusted badly. The remaining two strains did not rust, but rust was not severe where they were growing.

A further series of cultures which had shown increased resistance to K2 were sown under irrigation through the dry season and replanted at the end of June. Growth was satisfactory, and these wheats, as a result of this double multiplication, are now in the bag stage and available for issue. They have a smaller, better shaped grain in most cases, which bushels well, and seedling inoculations show them to be highly resistant to K2. Their behaviour in the field has, however, yet to be tested. During the year they were all inoculated for Form K1, and, as was expected, showed resistance.

One or two of these No. 130 strains also show resistance to leaf rust. Most strains are resistant to yellow rust, and have white grain.

Cross No. 172, *Njoro Hybrid x Reliance*

Further selection has taken place in this cross, which is now in the fourth generation. Plants have been obtained free of stem rust. A satisfactory characteristic of plants kept is their resistance to leaf rust, derived from the Reliance parent. Most plants are rather long maturing, and the straw of some is inclined to be weak, partly due to its length. The appearance of the grain is good.

Crosses Nos. 202 *and* 203, *No.* 112 *Hybrid x Kabete Hybrids* (*Nos.* 286.B.11.B.(L) *and* B.60.B.12.B.14(L))

Rust-free F3 plants have been harvested, but nothing quite as early as the Kabete hybrid has been obtained. Some of the grain is particularly attractive. These two crosses will be grown at the high-altitude yellow rust station at Molo in 1937.

Cross No. 142

One pure line selection only was eventually kept, and this was grown in a small multiplication plot. Its future largely depends on its baking qualities. It was noteworthy for its marked resistance to leaf rust.

Cross No. 179, UX.9.M.1.A. *x Kabete Hybrid*

A number of strains were bulked at the end of 1935 as being similar and possessing the same stem rust resistance. This resistance for K1, K3 and K4 was only moderate, though marked for K2. Nine bags were issued to a grower, and this wheat grew well and showed no stem rust, though wheat adjacent to it was rusted with K2. It matures in about the same time as Sabanero, and is suited to the lower altitudes up to 7,000 feet. Its future rests on its baking qualities, which to date have been somewhat variable, and on the nature of its rust resistance in the field.

DC x Ceres 721

This Canadian wheat is being multiplied up on account of its stem rust resistance to all four forms. In the field, however, it has not shown complete resistance to Form K4. In other respects it should prove a useful wheat.

New Crosses

A large number of crosses in the F2 generation have been grown and selections made.

Further crosses have also been made, the F1 generation of which is being grown on at the Scott Agricultural Laboratories over the short rains, and first crosses made.

Yield Tests

These were continued this year and comprised at Njoro a randomized block of 27 varieties replicated six times. It is only by seeing which wheats yield best over a period of several years that an accurate decision as to their yielding capacity and general suitability to the district can be made.

Australian Kenya Hybrids

A big range of cross-bred wheats was received from New South Wales, Australia, through the courtesy of Mr. Wenholz, the Director of Plant Breeding. These mostly consisted of Australian wheats which had been crossed with Kenya wheats. A number of very promising types were selected which showed resistance to leaf and stem rust and possessed excellent straw,

and the best of these will be grown on. The appearance of the grain under Kenya conditions was disappointing in many cases, though the grain as received was satisfactory. The Kenya x Gular and the Kenya x Florence x Dundee crosses showed the best stem rust resistance, and in both cases the Kenya parent used was one of the Njoro wheats, K.2.G.6.A.9, or "Chorlim" as it is sometimes called. These wheats all showed susceptibility to yellow rust, as does K.2.G.6.A.9, but they should suit the lower altitudes, and the apparent combination of resistance to leaf rust and stem rust is a valuable one.

Wheat Breeding at Rongai

The Scott Agricultural Laboratories' hybrids previously grown at Kabete were this year moved to the experimental plots at Rongai. They were therefore within easy range of Njoro, and, as the harvest at Rongai is later than at Kabete, ample time was given the writer to examine them after his return from home leave. Irrigation is not available at Rongai, and in a dry year growth is poor. Despite early, good rains, a dry spell at flowering retarded growth, and a moderate harvest only was experienced.

An artificial rust epidemic was created, and Forms K2 and K4 were also naturally present to some extent. The wheats sown were mostly in the F3 and F4 generations, and consisted of crosses of Reliance, No. 58.F.(L.1), and a No. 117 wheat with the Kabete wheats. All the Reliance crosses showed too much rust and were discarded. Plants were, however, obtained free of rust from the other crosses, and these will be carried on.

Trial and observation plots of some of the Njoro pure lines were also sown to test their suitability to Rongai conditions.

Molo Sub-station

Pure line wheats were again subjected to yellow rust tests and a randomized yield trial of 22 varieties was laid down, which served as a useful high-altitude test for the varieties in question. A second yield trial, comprising 18 varieties, which had been multiplied up under irrigation at Njoro earlier in the year, was also laid down in July. Owing to late planting and subsequent adverse conditions, poor growth was made, and statistical results will not be obtained. A number of the wheats showed very high resistance to yellow rust under the severe testing conditions experienced at this station.

Diseases

Stem rust is dealt with separately. Leaf rust was generally epidemic throughout the country, and in one area in particular was very bad indeed. Yield is decreased by the production of fewer and lighter kernels. The incidence of yellow rust, whilst normal at the higher altitudes, was more severe than usual at the medium heights. One case of serious damage by yellow rust was reported on Cross No. 112 at the 9,000 ft. level, but elsewhere this wheat showed itself to be reasonably resistant. The yellow rust differentials were grown for the Plant Pathologist, but owing to their varying length of maturity and their susceptibility to stem rust they are unsuited to local conditions. The behaviour of some of the Kenya hybrid wheats over a period of years do, however, indicate the presence of more than one physiologic form of this rust.

Black chaff and glume blotch were, as usual, present but not serious.

"Take-all" was again of major importance at the higher altitudes, and in these areas nothing less than rigid adherence to the recommendations laid down for its eradication will save farmers from heavy annual losses as a result of this disease. The inability to replace a large area of wheat by some other suitable crop is of course the difficulty, and in this respect the possibility of putting down an acreage to pyrethrum, of of increasing the existing acreage, is worthy of consideration.

Analyses of Baking Quality

These analyses have been continued this year, and samples were again sent to Dr. D. W. Kent Jones through the courtesy of Messrs. Unga Limited. The tests carried out in 1935 at high altitudes failed to confirm the suggestion that excessive stability in relation to general strength was the result of altitude. The experiment has, however, been repeated in 1936. Climatic conditions in this country are anything but constant, and they undoubtedly play a big part in the variation of analyses experienced from year to year on any particular variety.

Many of the new wheats are somewhat stable in character, and under adverse conditions this stability is increased whilst the general strength figure tends to be lowered.

Unfortunately, owing to shortage of staff, no work on the use of Pelshenke's wholemeal fermentation time test for testing pure line hybrids was made.

Laboratory Tests of Stem Rust Resistance

The Botanical Section again performed stem rust inoculations of seedling plants of pure line hybrids and of imported varieties. A large series of tests were made with the suspected new form, and in addition rust collected from the growing crops in different districts was sent down for identification. Thanks are due to the Senior Plant Pathologist for carrying out this work.

Pyrethrum

This year all the selected pyrethrum material was moved to a farm at Njoro at the 8,000 ft. level, which would be more representative of the main growing area of the country. Opportunity was taken to increase the stock still further by division during transplantation, and it is hoped that, during 1937, periodic weighings of pickings from individual lines can be started. Many of the selected plants certainly appear to be far superior to the ordinary farm crops as regards both number and size of flowers, as do some of the crosses.

Some Russian seed imported for trial has not been proved a success under Kenya conditions, and has been discarded. The plants proved to be shy flowering and the pyrethrin content to be below standard.

Maize Breeding

At Njoro twenty-three F5 lines, comprising 124 cobs, were planted; 749 plants in these lines were selfed. At harvest 157 cobs only from these plants were kept, and these cobs will undergo further selection before the 1937 planting. In addition, six single crosses and three double crosses and their reciprocals, made in 1935, were grown on, whilst 24 single crosses and 12 double crosses were made in 1936. A good growing season was experienced, and pollinations generally were satisfactory, though a dry spell of weather at this period was not helpful.

Little further segregation took place, but some lines showed a further loss of vigour, and in this respect it is doubtful if one family characterized by marked earliness will be able to be maintained.

There was a fair incidence of disease, both white blight and *Fusarium* sp., and as regards the latter the final criterion adopted was the infection of the cob. One other outstanding character in a number of lines was the high position of the cob on the stem, and it is hoped that this undesirable factor may be eradicated by suitable combinations of crosses.

Mr. Ball was responsible for the initial selection of plants for selfing, and Mr. Noble for the pollinations themselves. Of the six single crosses made in 1935, two only were found to be compatible.

The three double crosses and their reciprocals were planted together with some selected farm seed as a control. The whole plot received a heavy application of dung before planting. Growth was excellent, and the double crosses in particular stood out in the earlier stages. There was, however, marked variation between them eventually, and at harvest it was found that there was no difference between the best of them and the control maize. This is not surprising, as the control maize, due to the excellent season and the manuring, yielded 25 bags per acre, which can be said to be the maximum yield expected under Njoro conditions. A further series of double crosses will be tested statistically in 1937.

Oats

A further collection of hybrid oats was received from New South Wales, Australia, and grown at Molo. All of these proved susceptible to stem rust, with the exception of a Lampton strain and one or two Lampton hybrids.

The Lampton variety, which was received from New South Wales in 1934, has to date proved the most resistant variety to stem rust tried. It has yet to rust to any extent at Molo, though it was fairly attacked at Njoro in 1935.

Yield trials were carried out with this variety at Njoro and Molo this year, and it alone of the five varieties tried did not rust. No statistical analysis of yield was obtained. This oat is resistant to smut in Australia, and grown at Njoro next to a variety which was badly smutted, in a half-drill strip experiment, it remained unaffected. This seed will be grown on in 1937 to see if any smut infection was incurred from the adjacent infected variety. A few bags of Lampton have been issued to farmers for trial and multiplication.

Other imported varieties tried were Parker's Naked Oat and Langgewens Oat. The naked oat was badly affected by stem rust and fairly by crown rust. In view of the interest shown in this oat, it should be said that trials in England show it to be a very poor yielder, and this fact, coupled with its susceptibility to rust, make it unsuitable for local conditions.

Langgewen oat was medium early maturing, and made good growth. It was, however, badly attacked by stem rust.

The oat differentials were again sown at Njoro, Rongai and Molo in conjunction with the Plant Pathologist. The varieties Lampton and Biffen, however, by their reactions at different centres, have shown the presence of more than one physiologic form in the country. Further trials of Biffen's hybrid confirm its suitability for hay and ensiling, but not for seed.

R. J. LATHBURY,
Plant Breeder.

Part III.—Chemical Section

REPORT OF THE SENIOR AGRICULTURAL CHEMIST

Staff

Mr. L. Burton, Junior Laboratory Assistant, returned from long leave on 10th February. Mr. McNaughtan, Laboratory Assistant, was absent on long leave from 14th March to 26th October.

Work Done

Rather fewer samples were received this year, owing to more intensive work being undertaken on certain aspects, when, although a number of individual samples may be taken, a single entry may be made. In this connexion may be instanced the study of pyrethrum drying, where in all some 70 samples were analysed but only five recorded. The nature of the samples is given in tabular form below:—

Nature of Sample	Pending 31–12–35	Received	Examined	Pending 31–12–36	Total
Soils	27	213	240	—	240
Fertilizers	—	28	28	—	28
Essential Oils ..	—	30	30	—	30
Pyrethrum	—	78	76	2	78
Coffee	—	25	4	21	25
Sisal	—	25	25	—	25
Waters	—	14	14	—	14
Miscellaneous ..	—	10	10	—	10
Total ..	27	423	427	23	540

Soils

The Soil Chemist reports on most of the soil work.

The rains during the first half of the year caused much erosion, and very large quantities of soil were carried down the rivers in the Fort Hall Reserve. Cases were observed where the silt accumulation was a couple of feet deep in the beds of small streams, where fields of maize had been almost overwhelmed by silt, and yet others where several inches of soil had been carried away. Since then it is learned that the people in this area have become very erosion-conscious.

It is also learned that in European areas broad-base ridging is proceeding apace. There has been a great increase of

interest in soil conservation during the past year. Steps will have to be taken to arouse the stock farmers. For example, between Gilgil and Thomson's Falls, a very dangerous type of erosion was observed. Stock being watered had bared the soil on the stream-banks, and water percolating down through the grass has caused headland erosion, which is now cutting back at an alarming rate.

Fertilizers

The subject of fertilizers as a whole will be discussed by the Soil Chemist.

There are a few points which call for attention here. Many of the samples of compost brought in for examination have an ash content of 80 to 85 per cent. It is certain that many are slavishly following the details of the original Indore technique, which calls for a good deal of earth, without realizing the function of the soil. The Indore soil contains about 2 per cent of calcium carbonate, and is added to supply this. Most Kenya soils are acid, and so the use of so much is defeating the real object. Very little soil is required; the writer has produced very good composts without any addition of soil.

It is pleasing to record that applications of manures are being increased to a respectable level. Instead of an application of 150 lb. per acre of mixed fertilizers being considered most liberal, many coffee planters are applying 450 to 600 lb. per acre, and benefiting therefrom. We can confidently expect a considerable increase in the use of fertilizers, especially of the by-product fertilizers, in the course of the next few years.

Essential Oils

Peppermint has always appeared to be a most promising crop. The quality of the oil has been satisfactory, and, under suitable climatic conditions, has grown very well. It was hoped that this year large quantities would be exported—the growth was so vigorous. Just before harvest, mint rust appeared and almost completely defoliated the plants, reducing them to a condition valueless for distillation. Practically every field of peppermint, both English and Japanese, in the Colony has suffered most severely. Whence this infection arose is a mystery, but it has wiped Kenya off the map as a source of peppermint oil.

The experiments on lavender have progressed. The true French lavender has been a disappointment at the high altitudes, and experiments are being extended to lower altitudes.

Of the various strains of English lavender, "Seal" and "Giant Blue" have been the most promising, and give marketable oils. A very fair area has been planted up to the former variety.

Several new areas of geranium have been planted up, from all of which good oils have been produced. An outstanding oil was produced on an estate in Sotik. All these new plantings should be producing commercially next year.

A scare of a new disease in geranium arose during the year. The Senior Plant Pathologist could find no disease organism, while cuttings of affected plants developed normally here. The condition can only be due to climatic or cultural conditions, and need cause no fear.

The production of the oil from *Cymbopogon afronardus* on a commercial scale will probably start next year.

Pyrethrum

A close study of pyrethrum-drying has been made during the year. There was no information available regarding the temperature at which it was safe to dry pyrethrum. As a result of a number of experiments it has been found that it is safe to use temperatures up to 130° F., at which temperature there is a small loss in pyrethrin content.

By means of a small model tunnel drier with carefully regulated temperature, the dynamics of pyrethrum-drying were studied. Drying of mature flowers is more rapid if the fresh flowers are started from the hotter and drier end, and the temperature reached in the drying flowers is lower when the reverse method is employed. Immature flowers under the former conditions do not dry at all; the soft achenes dry out on the surface, becoming case-hardened. In commercial picking there is always some proportion of immature flowers, thsu the system of starting from the cooler, moister end must be followed. Also, in the oast-house type of drier, it is preferable to start drying at a comparatively low temperature and slowly to raise it, as drying proceeds, to the permitted maximum.

The oast-house drier is exceedingly wasteful of heat; so much escapes up the central passage. A modification has been produced by Mr. R. O. Barnes, of Ainabkoi, in which the drying chamber is virtually converted into a series of through-draught tunnels, through which the flowers are passed against the air current. This has been adapted to a flue-heated drier,

which has been named the "Ainabkoi Drier," and which has been described in an article in the *East African Agricultural Journal.*

Tattersfield has found that, as the flower develops, the percentage and absolute amount of pyrethrins increase until the flower is fully opened. The absolute amount of pyrethrins remains constant in the ripening flower head but, as the weight increases, the percentage drops. In England practically the whole flowering appears in a few days, so it is possible to pick each stage successively; in Kenya a plant may have every stage, from small closed heads to ripe seed, at one time. Thus it appeared desirable to repeat Tattersfield's research here. Every stage was picked on one day. The analytical results agree remarkably well with those of Tattersfield. Therefore we may conclude that at the height of the flowering season there will be very little variation in the pyrethrin content. There are, however, indications that major climatic variations do affect the flowers, not only in size, but in pyrethrin content, and an investigation into this is in progress.

A collaborative research is in progress with Dr. Gnadinger to investigate the extent of the deterioration during the voyage between Kenya and the United States of America. Incidentally, from this will also appear what would be the pyrethrin content it would be possible to guarantee for Kenya pyrethrum, and so fix a premium over Japanese.

In the case of the first consignment, which left Kenya at the end of September and was analysed in Minneapolis early in December, the average of the pyrethrin content of the nine samples on despatch was 1.72 per cent, on arrival 1.58 per cent—a loss of 8.1 per cent, the figures being calculated to dry weight. The average pyrethrin content of the 23 samples exported in 1936, calculated to dry weight, was 1.68 per cent. Thus it appears that Kenya could easily guarantee a pyrethrin content of 1.30 per cent on arrival and as received. If this can be done, a substantially higher premium over Japanese would be obtained.

Coffee

In reality many more samples of coffee were taken, but as they were in collaboration with the Coffee Section they were not recorded.

A preliminary investigation into the effects of lime on fermentation and quality was conducted with the Coffee Section, and the results reported in the Bulletin of the Coffee Board.

A preliminary investigation was conducted into the Roach injection technique, whereby it is possible accurately to study the effects of nutrients upon coffee. It is evident that injections must be made towards the end of the dry season, when solutions are rapidly absorbed. The results of the preliminary experiment to ascertain the effects of nutrients are not yet available.

The majority of the samples recorded were taken in connexion with the spectrographic exploration into the relationship between the mineral nutrition of coffee and coffee berry disease. All the apparatus for this did not arrive till very late in the year, so the work had to be postponed till next year.

Dieback, due to a deficiency in carbohydrate reserves, has been much more prevalent this year. Until a few years ago it was restricted to a few areas, but now is common almost everywhere. The writer is of the opinion that the state is really ascribable to the climatic conditions during the past few years. For a great deal of the period of crop development there has been high light intensity which depresses carbohydrate synthesis. It is believed that an alteration in the usual manurial programme may assist in increasing the accumulation of carbohydrates and other plant foods. An article on this will appear next year.

Sisal

The work on sisal has been undertaken by the Soil Chemist, who reports upon it.

Waters

These have been routine samples. A few of the samples have been of waters that have caused corrosion in boilers. Usually these waters have contained very little dissolved inorganic matter, but their pH has been low. The only possible cause of the corrosion is the acidity of the water, and the addition of soda ash to the water has been recommended. It is highly probably that acid waters are responsible for more boiler corrosion in Kenya than in realized.

Miscellaneous

There have been one or two interesting items under this heading.

An investigation was conducted into the possibility of producing a tea-sugar brick for direct consumption by natives. It was possible to produce hard bricks, but so much sugar, 7½ and 10 times the amount of tea, was needed to meet native tastes that the final production was really a sugar lump flavoured with tea.

A certain amount of work has been done on a variety of tobacco with a high nicotine content. Large quantities of nicotine are employed in Great Britain for insecticide purposes, and it appears this market could readily be entered on a satisfactory basis. This work will be extended next year if possible.

In conclusion, the thanks of the Section are due to the Imperial Institute for the investigations into essential oils; to Captain C. T. Soames for his collaboration in experimental growing of essential oil plants; to Mr. R. O. Barnes for the great assistance he has given in the pyrethrum drying investigations.

V. A. BECKLEY,
Senior Agricultural Chemist.

REPORT OF THE SOIL CHEMIST

During the year 240 samples of soil, including 27 samples held over from the previous year, and 28 samples of fertilizers were dealt with. An analysis of the soil work gives the following calssification of laboratory work involving soil analysis: 103 soil samples were examined and reported upon for private individuals; 99 samples dealt with laboratory investigational work, whereas the remainder dealt with general survey work. It is pleasing to record that most of the soil samples examined for private individuals were brought to the laboratories by the farmers themselves, thus it was possible to obtain field information about the soil sample and manurial and cultural problems could be discussed while simple tests were carried out. There has been a falling-off in the number of imported mineral fertilizers analysed. Most of the work done on manures and fertilizers refers to local supplies of limestone, compost and local by-product animal manures. During the year 25 samples of sisal line fibre were examined in the laboratories with a view to improving factory preparation methods.

Soil Investigational Work

The continuation of laboratory work on the phosphate status of the Kikuyu red loam, the major coffee soil of the Colony, has reached the stage when it is possible to give sound advice on the economy of the phosphatic manuring of this soil type. It has been found that water-soluble phosphates react immediately with the reactive soil colloids in the special case of these laterized red acid soils, such that the added phosphate loses its water-solubility and becomes about equally "available" as that added in the form of mineral phosphates. Another feature of the reaction between water-soluble phosphates and these red soils is that added materials are held in the surface layers of the soil, and thus can only come in contact with a small portion of the root system of the coffee tree. When a weak solution of superphosphate is added to a four-inch column of dry soil such that there is just sufficient to moisten the whole of the column, it is found that the whole of the added phosphate is contained in the upper inch of the soil column. This illustrates the very high phosphate-absorbing capacity of these red acid soils: the upper inch of soil held phosphate equivalent to 0.2 per cent P_2O_5, while the underlying layers, though moistened by the solution, contained about 0.01 per cent P_2O_5 only. Another instance of the relative immobility of added phosphates is shown by the analyses of soil samples taken at different depths from

a plot of coffee which received, in this instance, mineral phosphate at the rate of 100 lb. P_2O_5 per acre, in 1929. After seven years, following numerous cultivations, it is found that most of the added material is still retained in the upper four inches of soil. There is a small increase in the second four inches of the fertilized plot as compared with the control, and it is likely that some of this increase has been brought about by the repeated cultivation beyond the four-inch depth. There is no increase in the reserve of phosphate below a depth of eight inches. In all cases, a field examination of the soil profile in old coffee plantations which have received organic manurial applications over long periods show increased reserves of phosphate in the cultivated surface soil only. There has been very little downward movement in solution beyond the actual depth of cultivation. This narrow zone of accumulated phosphate reserves is further limited by the desiccation of the surface soil during dry weather; hence, in the case of these very absorptive red acid soils, it is important to have a good distribution with depth of added phosphates. In mature coffee this can be partly brought about by deep cultivation following the broadcasting of the phosphatic fertilizers on to a dry soil; with new plantings, the possibility of the thorough incorporation of added phosphate with the excavated earth and its subsequent distribution to a good depth will add to the benefits of taking greater trouble in the initial planting out of coffee. It is proposed to do further laboratory work on the mobility of phosphates under different conditions of local soil reaction and humus content. In the meantime it is advised that, in the case of laterized red acid soils, the cheaper phosphatic fertilizers, such as mineral phosphates and bone meal, are at least as suitable as the more expensive, chemically prepared, water-soluble forms. This advice also applies to the nature of the phosphate ingredient of compound or specially balanced coffee fertilizers.

Some soil analyses were carried out to find the effect of different surface coverings on total soil nitrogen. Adjoining plots given over to a leguminous cover crop (*Glycine javanica*) for a period of five years, as compared to clean cultivation, showed a well-marked difference in the appearance of the natural soil. Soil analysis of the surface eight inches of soil taken from duplicate plots showed that differences of 0.050 per cent and 0.45 per cent respectively of total nitrogen in favour of the land under the permanent cover crop. The average content would be equivalent to about 4,000 lb. per acre and 5,000 lb. per acre respectively of total nitrogen.

Similar comparative soil analysis showed a marked improvement in the soil nitrogen-status brought about by two years' growth of Napier grass, and more especially in the case of an old stock paddock.

Coffee

It will be appreciated that soil investigational work done on the Kikuyu red loam has special application to coffee, as most of the existing plantations occur on this and other fairly similar soil types.

Towards the end of the year laboratory work was initiated on the prevention of the pollution of streams by coffee factory effluents. It is found that coagulation and centrifugal separation following the addition of small amounts of alum remove about a third only of the total oxidizable matter. The larger portion of the factory effluents consist of various organic constituents present in solution and therefore not removed by the usual methods of coagulation followed by filtration. This may necessitate the installation of biological filter beds for the efficient treatment of coffee factory wastes. It is found that about half of the total waste matter produced in the fermenting tanks can be removed by the vigorous stirring of the fermented beans with an initial limited quantity of water, which is then removed from the system previous to the subsequent washing and grading of the coffee. In the meantime it is advised that this first thick "washing" water be diverted separately into a series of seepage pits, thus greatly lessening the load of waste matter entering the streams.

A detailed survey of soil conditions in relation to the incidence of coffee berry disease in the Sotik and Nandi districts has been carried out. About fifty representative soil profiles occurring on twenty-five plantations which had had varying amounts of this coffee disease were examined, and laboratory work carried out on very numerous soil samples. The survey failed to show any direct correlation between soil conditions and the incidence of the disease, but there is evidence that the "lie of the land", as it affects local variations of the micro-climate, does modify the distribution of this disease, more especially in the areas where this fungoid disease is usually less severe. It is appreciated that "climate" in a general sense plays the dominant rule in governing the regional distribution of the disease: it is always more serious in coffee situated in more elevated, humid and cooler climates. As we diverge from the optimum climatic conditions for the

fungus, then micro-climatic factors governed by relative topography appear to be able to shift one way or the other the incidence of the disease. The disease is present on coffee grown on a wide range of soil types; but it is found to be relatively more severe on the lower slopes and within shallow depressions, whereas it is usually less severe on open high ground. Over most of the worst coffee berry disease areas the general climatic conditions are about the extreme for successful coffee growing, and so favour the propagation of the fungus that no practical amelioration is possible other than by a change over to a more suitable coffee variety or by success in the selection of resistant or very much less susceptible types from amongst the present coffee populations.

Sisal

Work on the better preparation of sisal line fibre has been continued. Determinations of water-soluble dry matter and acidity of the water-extract have been carried out on 25 samples of line fibre subjected to varying preparation methods. Commercial bales of sisal fibre decorticated with normal and low flow of water, and with and without subsequent centrifugal washing and drying, were submitted to the Director of the Linen Industry Research Association, Lambeg, for a report on the commercial quality of the fibres. It was found that though further centrifugal washing and partial drying did somewhat reduce the rigidity, different preparation methods tended to be masked by differences in the natural fineness of the fibre in the different bales: with similar initial fibre, better washing does seem to improve the quality of the commercial product. Different parcels of prepared fibre sampled at the factory and again after an interval of 7½ months, including a period in the bales under commercial conditions, were analysed at these laboratories. Generally speaking, there had been very little change in the composition of the fibre, and it is considered that no significant information can be drawn from the two sets of analytical data. The cellulose content varied between 74 per cent and 77 per cent in the case of these East African fibres.

The relative out-turn and the efficiency of abstraction of two types of decortication under fairly normal working conditions have been determined. The daily out-turn of fibre per ten-hour shift is estimated to be 28 tons and 40 tons for the Magnall II and Corona IIB decorticators respectively; whereas the relative amount of fibre abstracted is indicated by the values 3.51 per cent and 3.33 per cent of unbrushed air-dry

fibre for these same two decorticators. The Magnall II abstracted about 84 per cent of the total fibre, as against about 77 per cent by the Corona IIB. Both decorticators caused the waste of about 13 per cent of the total fibre at the butt end, whereas the tip end losses were about 3 per cent and 9 per cent for the Magnall II and Corona IIB decorticators respectively.

Soil Survey

Owing to the pressure of work likely to give more immediate economic return, very little time has been devoted to general survey work during the year. Soil samples collected during economic surveys have been classified, and new series names have been allotted to certain soil conditions. To date, the register of soil series and their distribution gives information about 109 natural soil profiles falling into 37 separate soil series. The number of individual soil samples collected and recorded now amounts to 268. In all cases the normal pH values by the hydrogen electrode method have been determined; otherwise chemical data about the soils are strictly limited.

General

At the Nakuru Agricultural Show the writer collaborated in the preparation of a special model of a mixed farm illustrating various appropriate methods of conserving soil fertility. Papers on "The Conservation of Soil Fertility on Coffee Estates with Special Reference to Anti-erosion Methods," and on "The Manuring of Coffee," were published during the year. A chapter on "Coffee Soils and their Treatment" has been contributed to the departmental publication, *Coffee in Kenya.*

G. H. GETHIN JONES,
Soil Chemist.

Part IV.—Report of the Entomological Section

Staff

Mr. Wilkinson, Entomologist in Charge, returned from leave on 28th June. Dr. Le Pelley, Entomologist, was absent throughout the year, continuing his studies in America until June, after which he proceeded to Hawaii, Japan and the Philippine Islands in search of parasites of *Pseudococcus lilacinus* Ckll. As a result of the award of a Commonwealth Fellowship and the subsequent work undertaken by Dr. Le Pelley, this officer has now been absent from the Colony for some two and a half years. Mr. F. B. Notley, Entomologist, was responsible for the work of the Entomological Section from 1st January until my return from leave at the end of June. Mr. Notley left the Kenya service on 31st October, on transfer to the Tanganyika Government as Entomologist. I should like to place on record my appreciation of this officer's services during the past six years. Mr. A. R. Melville, Entomologist, arrived on 11th November on his first appointment. Mr. H. Naismith Jones, Plant Inspector, proceeded on leave on 4th January, and was recalled to duty on the 1st August, and posted to the Scott Agricultural Laboratories. Mr. C. D. Knight, Plant Inspector, assisted Mr. Notley at the Scott Agricultural Laboratories until he preceeded to England on leave on 24th May. This officer was absent from the Colony for the remainder of the year. Mr. E. Cottington, Plant Inspector, remained seconded to the Botanical Section throughout the year for duties in connexion with coffee berry disease investigation. Mr. C. Fielding Fox took over from Mr. Naismith Jones the Kasarini Field Station, and remained in charge of this station throughout the year.

Administration

Correspondence, routine work, interviews, identification of specimens and general advisory work are increasing to such an extent that little time remains to the officer in charge for investigational work, which must be undertaken more and more by members of his staff.

Pressure of work has been considerably relieved by transferring the administration of the Diseases of Plants Prevention Rules to the Senior Plant Pathologist.

Investigational Work

Coffee Mealy Bug (Pseudococcus kenyae *Le Pelley*)

This insect continues to be the most serious insect pest of coffee in Kenya, and the problem of its control is engaging the whole time of two Entomologists, one Plant Inspector and the part time of the Entomologist in Charge. It is still considered that the best possible chances for successful control are presented by the introduction of predators and parasites of *P. kenyae* from neighbouring territories and predators and parasites of closely related mealy bugs which are known to exist in the Orient, or, more important still, the discovery of *P. kenyae* and its parasites in the East. Through a generous grant of money from the Colonial Development Fund, Dr. Le Pelley was enabled to proceed to the Orient to search for parasites and predators, and a quarantine laboratory was erected at the Scott Agricultural Laboratories in Kenya for their reception and breeding. In the absence of this quarantine laboratory, the reception of living insects from abroad would have been attended by considerable danger. In April, Dr. Le Pelley despatched *Leptomastix dactylopis* How. from California to Dr. Thompson, but this material failed to reach England satisfactorily. Later in the year two consignments of *Pseudococcus krauhniae* Kuw., parasitized by *Pauridia peregrina,* were despatched from Honolulu and one consignment of *P. krauhniae,* parasitized by *Clausenia purpurea* Ishii. and *Anagyrus suballipes* Ishii., was despatched from Japan. From these three consignments no parasites emerged except six Pauridia from the first consignment from Honolulu, and these failed to breed in our mealy bug, *P. kenyae.*

From the beginning of August until the end of the year Dr. Le Pelley had his headquarters at the School of Forestry, Agricultural College, Laguna, in the Philippine Islands. Soon after Dr. Le Pelley's arrival in the Philippines he discovered the mealy bug, *Pseudococcus lilacinus* Ckll., on eight different host plants, and it is interesting to note that he states, "This mealy bug is reported as not being commonly found on coffee in the Philippines."

It may be remembered that the common coffee mealy bug of Kenya went under the name of *P. lilacinus* for many years until re-described in 1935 by Le Pelley as *P. kenyae.* It is now somewhat surprising to learn from Dr. Le Pelley "that *P. lilacinus* is readily distinguishable by the naked eye from *P. Kenyae.*" Nevertheless, these two mealy bugs are

undoubtedly very closely related, and it was of great importance to discover parasites of *P.lilacinus*. After some weeks in the Philippines, Dr. Le Pelley had discovered and reared some nine different species of parasites, two of which, *Pseudophycus* sp. (new) and *Anagyrus* sp. (new), were considered of sufficient importance to warrant efforts being made to establish them in Kenya.

Between 28th October and the 24th November, four consignments of *Pseudococcus lilacinus* Ckll., parasitized by *Pseudophycus* sp. and *Anagyrus* sp., were received in excellent condition. Each consignment was opened in an insect-proof cage within the quarantine laboratory, and all subsequent experiments conducted in this quarantine room.

Some 35 specimens of *Anagyrus* and 3,300 specimens of *Pseudophycus* emerged alive from the *P. lilacinus* mealy bugs, and these were utilized in 62 experiments in an endeavour to provide suitable conditions for oviposition in *P. kenyae*. After emergence the parasites fed upon either a weak solution of honey or upon raisins, sugar and water, and on this food they were kept alive for as long as fourteen days.

In the case of *Pseudophycus,* copulation was observed to take place immediately upon emergence. Dissection of newly emerged females showed the ovaries to be fully developed with a few well-developed eggs present.

Dissection of females eleven days after emergence showed the ovaries to be of the same size as the ovaries in newly emerged females, but containing a larger number of fully developed eggs.

In no single experiment was oviposition observed, neither were eggs discovered on dissecting hundreds of mealy bugs of *P. kenyae* which had been in contact with *Pseudophycus* for varying lengths of time in the different experiments. Several hundred specimens of *Pseudophycus* were liberated on mealybug infested coffee bushes in cages and in the open at the Scott Laboratries and at Thika, 36 miles away, but no recoveries have yet been made.

Experiments were conducted using various preparations of dead mealy bugs of *P. lilacinus* smeared and dusted over specimens of *P. kenyae*; other specimens of *P. kenyae* were dusted with wax alone taken from *P. lilacinus,* and in each case small or large numbers of *Pseudophycus* were allowed access to the mealy bugs in the hope that the requisite stimulus

might be provided for oviposition. While in these experiments *Pseudophycus* appeared to be greatly excited, and examined the mealy bugs very carefully, oviposition did not take place.

Since the mean temperatures and the relative humidity in the Philippines are considerably higher than those occurring at the Scott Agricultural Laboratories, experiments were conducted at mean temperatures of 78° F. and relative humidity of 70 per cent. Again oviposition did not take place, and it can only be concluded that *Pseudophycus* is capable of distinguishing *P. lilacinus* from *P. kenyae* and that this insect will not oviposit in the latter mealy bug. It is well known among entomologists how specific in their attack are some of the parasites of mealy bug. Nevertheless, when it is considered how small are the characters by which scientists have separated the two species of mealy bug, *P. lilacinus* and *P. kenyae,* it is remarkable that *Pseudophycus* is able to discover within a few seconds differences which it has taken mealy-bug specialists years to determine.

I should like to take this opportunity to express my appreciation of the careful, patient and efficient manner in which the above experiments were conducted by Mr. Melville. ably assisted by Mr. Naismith Jones.

Schizobremia coffeae Barnes

Further material of the predatorial Cecidomyid was received from the late Mr. Ritchie early in the year. This insect has bred freely on *P. kenyae* in the laboratory, and to date five large liberations have been made in the field.

Details of the life-history have not yet been obtained, but from breeding experiments it would appear that during the warmer months of the year a period of twenty-three days elapses between the time of liberation of newly emerged adults and the appearance of the next generation of adults. The rate of reproduction is considerably retarded during cold weather.

It is anticipated that this Cecidomyid will be a very useful addition to the indigenous predators, especially during the warmer periods of the year.

Infestations by mealy bug have been particularly severe during the period under review, and many complaints were received towards the end of the year to the effect that mealy-bug infested coffee trees, although effectively grease-banded against the ant, *Pheidole punctulata,* were not being effectively

cleared of mealy bug by indigenous predators in the manner normally experienced, and fresh outbursts of mealy bug continued to appear on the young shoots.

The weather conditions experienced during the year, though favourable to the rapid development of mealy bug, offered no explanation of this obstinate clean-up by predators, and the position became sufficiently serious to warrant special investigations being made. As a result of a rapid preliminary survey it has been found:—

(1) The predator, *Hyperaspis senegalensis,* was most abundant on every plantation visited, but only in the larval and pupal stages; few adults could be found. It was discovered that the pupæ of *Hyperaspis* were heavily parasitized by a hymenopterous parasite, identified as *Xenocrepis secundus* Craw. Laboratory examination of material collected has shown that this parasite lays its eggs externally between the developing legs of the pupated *Hyperaspis.* On hatching, the larvæ feed externally, and nine or ten may be present on one *Hyperaspis.* The larvæ of *Hyperaspis* are not attacked by the parasite. The adult parasite is a black chalcid wasp, and was observed to be active in the field. On one estate the rate of parasitism of the pupæ of *Hyperaspis* was 57 per cent, and it is evident that *Xenocrepis secundus* is a serious hindrance to *Hyperaspis* and is probably mainly responsible for the present serious mealy-bug infestation.

(2) *Chilocorus angolensis,* formerly an important predator, was very scarce indeed, and examination of material collected showed only two pupæ of this species parasitized by an internal parasite as yet unidentified. It is suspected that an egg parasite may be present, but the reasons for the scarcity of *Chilocorus angolensis* require further investigation.

(3) *Scymnus* sp. was present throughout the areas, but only numerous on one estate visited. Two *Scymnus* larvæ were found to contain an internal parasite (unidentified).

(4) Various other predators were found in small quantity.

The position in general would appear to be serious, since the presence of these parasites strikes at the root of the present accepted methods of control and renders grease-banding, which is itself an expensive operation, less effective.

Banding Experiments

(*a*) Various new banding greases are being experimented with. One in particular is said to cause no damage to young

trees when applied direct to the stem. This latter banding grease has remained effective against ants since the time of application, but sufficient time has not yet elapsed to allow of a report being made upon its possible effect upon the growth of the young trees.

(*b*) *Wood-wool—Castor Oil.*—Experiments were conducted using bands made of coarse and fine wood-wool, the surface being soaked with castor oil or smeared with banding grease. After two days the ant, *Pheidole punctulata,* appeared on the trees in small numbers above the bands; after four days innumerable numbers of ants were passing to and fro above and below the ants, though in no instance were ants seen crossing the outside of the bands. The results of the experiments clearly demonstrate that *Pheidole punctulata,* after a period of from two to four days, is capable of gaining access to the upper portion of a coffee tree by passing through the interstices of a wood-wool band when the latter is effectively treated with castor oil or banding grease. Bands made of wood-wool cannot be recommended.

(*c*) *New System of Banding.*—After much experimentation, a coffee planter has recently evolved an entirely new type of band. This band consists of a piece of galvanized iron, 22 in. by 4 in., placed in the form of a collar around the stem of the coffee bush at ground level. The space between the collar and the stem is then filled with three grades of murram. "Murram" is a term used locally for the rock known scientifically as Orstein, which is a granular iron deposit. The first grade murram consists of granules which do not pass through a coffee tray used as a sieve. The second grade consists of granules which pass through a coffee tray but not through a $\frac{1}{8}$ in. sieve. The third and finer material is that which passes through a $\frac{1}{8}$ in. sieve after all dust has been eliminated.

Grade 1 is placed within the collar to a depth of two inches; on this is placed approximately three-quarters of an inch of Grade 2, and on this again three-quarters of an inch of Grade 3, and finally the collar is filled with another layer of Grade 1; the collar is then tapped a few times to make the murram settle into position. When the whole is in position a band of creosote or a mixture of creosote and grease is placed around the outside of the galvanized iron collar. Bands of this description have been in operation for some two months, and to date the ants have not gained access to the coffee trees; there is, however, the possibility that ants may gain access to the coffee trees through the spaces which might appear be-

tween the surface of the coffee stem and the murram owing to the pressure exerted by the stem on the murram as a result of movement produced by wind action.

Should this type of band continue to prove successful the following advantages will be gained:—

(1) Suckers may be established at a low level on the main stem and at a more convenient height than is at present possible.

(2) One band only need be placed round multiple-stemmed coffee, instead of one band around each stem. Also multiple stems may be established at a more convenient height on the main stem.

(3) A considerable saving in material, labour and time.

(4) In areas where mealy-bug attendant ants and white borer (*Anthores leuconotus* Pasc.) are present together, this type of band will serve a dual purpose: (*a*) prevent ants from gaining access to the mealy bug, and (*b*) prevent white borer from laying its eggs near ground level.

(5) White ants are prevented from breaking down the bands as at present.

(6) There is little or no danger of causing damage to young or old coffee stems, since grease is not applied direct to the bark.

(7) Mealy bugs are prevented from clustering below the bands as at present.

(8) Larvæ of various predators of mealy bug are much less likely to be caught up in the grease bands on the collars than when grease is applied direct to the coffee stems.

The original cost of application of this kind of band is about Sh. 25 per acre, where trees are planted 9 ft. x 9 ft., as against Sh. 15 for banding grease alone. This is more than off-set by the smaller cost of upkeep and the advantages mentioned above. Also, murram is easily obtainable within short distances of most coffee estates.

Stephanoderes hampei Ferr.

The question of what are the conditions under which the entry of ex-territorial coffees to the Nairobi market will be allowed has occupied the minds of merchants and Government alike for a number of years. The crux of the whole problem appeared to depend upon an accurate determination

of the moisture content of coffee below which *Stephanoderes* cannot live. Experiments in this regard were conducted by Hargreaves, Government Entomologist, Uganda, and in an article which appeared in the *East African Agricultural Journal,* Vol. I, No. 3, Nov., 1935, Hargreaves states: "Damage to properly cured coffee cannot be caused by *Stephanoderes.* The reduction of the moisture content to 13.5 per cent for *arabica* and 12.5 per cent for *robusta,* or less, prevents the adult beetle attacking coffee, and beetles die of starvation in a few days in the presence of coffee dried to this extent." Since Hargreaves made no mention of whether eggs could hatch and larvæ arrive at maturity in such coffees, it became necessary to repeat the experiments, and these were conducted by Notley immediately prior to his transfer to the Tanganyika Government service. The results of Notley's experiments agree in the main with those obtained by Hargreaves, and though eggs may hatch in coffee of 11 per cent moisture content, all larvæ die within a few days and adult beetles within twelve days in *arabica* and *robusta* coffees with moisture contents up to 13 per cent.

There seems no doubts that desiccation and not lack of food is the cause of death.

As a result of the above experiments it would appear that coffees with a moisture content up to 12.5 per cent may be allowed to enter the Nairobi market with complete safety.

Antestia and Capsid Bug

A suitable technique having been evolved, dusting with pyrethrum powder, as mentioned in the Annual Report for 1935, is now the accepted method of control for Antestia and Lygus on coffee. The cost of application is from Sh. 5 to Sh. 7 per acre, and is roughly half that of spraying with pyrethrum-paraffin extract. One boy can dust one acre per day, using a small hand-dusting machine and applying twenty strokes of the pump per tree. It should be noted that unless pyrethrum powder is stored in airtight tins it loses toxicity fairly rapidly, and as far as possible only fresh powder should be used; even in airtight tins, pyrethrum powder loses toxicity. By using fresh powder, 98 to 100 per cent kill should be obtained in the field.

Waxy Scale (Ceroplastes destructor *Newst.*)

During the year under review seven consignments of heavily parasitized waxy scale were despatched to the Chief Entomologist, New South Wales. The predominant species of

parasites which appeared after arrival in Australia were *Scuttellista cyanea* Motsch. and *Diversinervus elegans* Silv. Other parasites of *Ceroplastes destructor* recorded in Kenya are *Eupelmus saissetiae* Silv., *Chiloneurus obscurus* Silv., *Coccidoxenus obscuratus* Wtstn., *Eucomys infelix* Enble, *Leptomastidix abnormis* Gir., *Tetrastichus gravans* Silv. The Chief Entomologist, New South Wales, has written saying that two new Encyrtidae have been obtained from the material forwarded from Limuru, also *Cerapherocerus innutilis* n. sp. (Comp. mss.), and it would appear that more than one species of white waxy scale occurs on coffee in East Africa. Samples of these white waxy scales have been sent by Mr. Gurney to Dr. H. Morrison, Bureau of Entomology, Washington, U.S.A., for determination.

Other insects recorded on coffee during the year are *Agnoscelis* (*Cimex*) versicolor F., *Isopoda* (unidentified) destroying the roots of coffee seedlings in a nursery, *Bixadus sierricola* White, *Cacoecia occidentalis* Wlsm. An Aleurodid, probably *Aleurocanthus* sp., *Apata monacha,* Fabr. It is reported that on one estate 14,134 adult beetles of *Apate monacha* were collected in 13 weeks. It would appear that the beetles were coming into the coffee from some outside source and were not emerging from the coffee stems on this particular estate. *Anthores leuconotus* Pasc., is a serious pest of coffee grown below 5,000 feet.

Cotton Pests

Owing to entomological staff being fully occupied in investigating the insect pests of crops grown by Europeans, our knowledge of the insect pests of crops grown by natives is very small indeed, and reliance must be placed almost entirely upon Agricultural Officers forwarding specimens collected in the field for identification. During the year under review the following identifications of insects attacking the cotton plant in the Central and Coast Provinces have been made:—

Sinoxylon sp., boring in the stem.

Lygaeus electus and *Lygaeus* sp., feeding on unopened cotton bolls.

Negara viridula, feeding on unopened cotton bolls.

Systates cribripennis, feeding on unopened cotton bolls.

Porthesia producta, defoliating cotton plants.

Amsacta sp., defoliating cotton plants.

Tareche apatelia, found on cotton.

Raphidiopsis ornata, found on cotton.

Erias insulana, spiny boll worm.

Dysdercus nigrofasciatus, *Dysdercus superstitiosus*, *Dysdercus pretiosus*, *Dysdercus fasciatus*, cotton stainers.

Platyedra gossypiella, pink boll worm; *Mometa zemiodides*, boll worm (Coast Province).

Oxycaraneus hyalipennis and *Oxycaraneus gossypinus*, feeding in open bolls.

Saisettia (*Lecanium*) *nigra*, on cotton stems from Kitui.

From these specimens of black scale the following parasites emerged:—

(*a*) *Scutellista cyanea* Motsch.

(*b*) *Baeoanusia olea* Silv.

(*c*) *Tetrastichus gravans* Silv.

(*d*) *Marietta* sp.

(*e*) *Encyrtus* sp.

Aphis gossypii Glov.

Owing to the drought experienced during the present season, aphis damage was considerable in the Sagana, Lower Fort Hall and Ndei districts.

Jassid (*Empoasca sp.*)

Jassid damage was common on cotton throughout the Central Province with the exception of Lower Emberre country.

Mealy Bug (*Pseudococcus kenyae*)

From 2 to 5 per cent of the cotton plants grown between pigeon pea (*Cajanus indicus*) in the area between Sagana and Karatina were destroyed by this mealy bug, and infestation was particularly severe. The pigeon pea was heavily infested, and the mealy bugs were passing from this plant on to cotton. It is recommended that cotton should not be interplanted with pigeon pea.

Maize

During the year maize grown in the Rift Valley Province has been heavily infested with stalk borer (*Busseola fusca* Fuller).

In the coastal belt, *Sesamia calamistes* Hmps. was found heavily infesting maize, *mtama* (*Sorghum caudatum* Stapf), and Napier grass (*Pennisetum purpureum*).

Orthesia insignis Dougl.

This mealy bug appears to be extending its range within the Colony, and is very destructive to many ornamental plants. The following plants have been found heavily infested with *Orthesia*:—

Cestrum aurantiacum (Solanaceae).
Jacaranda mimosoefolia (Bignoniaceae).
Holmskioldia sanguinia (Verbenaceae).
Tecomaria capenis, T. shirensis (Bignoniaceae).
Tecoma stans (Bignoniaceae).
Duranta plumiari (Verbenaceae).
Cotoneaster pannosa (Rosaceae).
Lantana (Verbenaceae).
Makayu bella.
Magnettia bicolor.
Achillea (Compositae).
Agathaea caelestis.
Coleus sp. (Labiatae).
Gaillardia (Compositae).
Gerbera Jamesoni (Compositae).
Salvia (Labiatae).
Statice latifolia (Plumbaginaceae).
Cupressus macrocarpa (Araucariaceae) (trunk only).
Duranta Plumieri (Verbenaceae).
Naartjes (Rutaceae).
Coffea arabica (Rubiaceae) (near to heavily infested Jacaranda).

Ramie

This crop is at present in the experimental stage, and only small acreages have been planted in various districts within the Colony. In two widely separated districts many of the plants have been completely defoliated by the larvæ of the butterfly *Acrea esebria,* forms *monteironis* and *pretiosus.* The larvæ of this butterfly normally live upon the indigenous plant members of the natural order Urticaceae, and since Ramie is also a member of this natural order it should be anticipated that the *Acraeas* may become a pest on this crop when grown on a commercial scale.

The caterpillars are gregarious, and when young are to be found congregated together upon the under-surfaces of the

leaves. As they increase in size they have the habit of completely defoliating a plant before leaving it to move on to the next one. The caterpillars are easily dislodged and fall to the ground when the plant is shaken vigorously.

Methods of Control

(*a*) While the caterpillars are young they can be collected by removing the individual leaves upon which the larvæ are congregated.

(*b*) As the larvæ increase in size they may be collected by shaking vigorously the attacked plants over a sheet placed on the ground.

(*c*) Where infestation is severe and the above methods are impracticable, spraying with lead arensate at the rate of 2½ lb. to 100 gallons of water is recommended.

ACKNOWLEDGMENTS

I should like to acknowledge with thanks the assistance received during the year from Sir Guy Marshall and the staff of the Imperial Institute of Entomology in the identification of numerous insects; the Conservator of Forests, Nairobi, for the identification of plants; Dr. Van Someren for the identification of butterflies and many plant specimens; the staff of Imperial Airways in Nairobi for their kind co-operation and assistance on the arrival of consignments of parasites.

H. WILKINSON,
Entomologist.

ANIMAL INDUSTRY

Part V.—Report of the Chief Veterinary Research Officer

Staff

Mr. R. Daubney, Chief Veterinary Research Officer, was on duty throughout the year. In addition to his own duties, Mr. Daubney was appointed to the post of Acting Deputy Director of Animal Industry and Chief Veterinary Officer during the absence of Major H. H. Brassey-Edwards, O.B.E., on vacation leave.

The post of Assistant Chief Veterinary Research Officer remained unfilled throughout the year.

Mr. J. R. Hudson, Veterinary Research Officer, proceeded on vacation leave on the 5th of December, 1936, Mr. W. B. C. Danks, Veterinary Research Officer, returned from vacation leave on the 23rd November, 1936, while Mr. W. Fotheringham, Veterinary Research Officer, and Dr. E. A. Lewis, Entomologist, were on duty throughout the year.

Mr. A. J. Kemp, Laboratory Superintendent, and Messrs. J. T. Schultz, H. J. Gray, J. R. McQueen, E. J. Hall, W. P. Bruce, and S. R. Pelling, Laboratory Assistants, were on duty throughout the year. Mr. J. Forsyth, Laboratory Assistant, returned from vacation leave on the 26th of June, 1936, and Mr. F. Lyons, Laboratory Assistant, returned from vacation leave on the 28th of June, 1936.

In addition to the foregoing, the following members of the staff were on duty throughout the year:—

Mr. G. M. Eames ..	..	Overseer.
Mr. J. H. Crampton	..	Accounts Clerk.
Miss R. M. Dennis	..	Clerk.
Miss J. Middleton ..	..	Clerk.
Miss K. Rushworth	..	Clerk.
Miss D. Gent-Wood	..	Clerk-Librarian.
Mr. O. Stenmark ..	..	Mechanic.
Mr. G. W. Clochley	..	Storekeeper.
Mr. D. N. Lewis ..	..	Laboratory Student.
Mr. D. H. McCalman	..	Laboratory Student.
Mr. T. K. Hill ..	..	Laboratory Student.

Mr. A. J. Wiley was appointed to the vacant post of Laboratory Student with effect from the 7th of January, 1936.

Dr. A. C. King, a visiting worker from London, returned to the laboratory in October, 1936, to continue his research work on cancer.

Dr. J. Anderson, Veterinary Research Officer, and Mr. J. A. Blundell, Farm Manager, were both on duty at the Experimental Station, Naivasha, throughout the year.

It gives me great pleasure to place on record my appreciation of the satisfactory manner in which the members of the laboratory staff have carried out their duties during the year under review.

Correspondence

5,848 inward and 4,260 outward letters and telegrams, a total of 10,108, were dealt with during the year. In addition to correspondence, 6,280 slides and specimens submitted to the laboratory were examined and reported upon. A detailed classification of these reports appears under "Technical Routine".

Laboratory Workshops

The various electrical, steam and gas plants at the laboratory were in constant use throughout the year and gave satisfactory service. Maintenance and repairs were carried out by the workshop staff under the supervision of the Laboratory Mechanic.

Laboratory buildings including staff bungalows were also kept in a satisfactory state of repair.

The question of supplementing the laboratory water supply is still under consideration by the Public Works Department, and it is hoped that the present inadequate supply will be increased in the near future. Unfortunately protracted periods of drought have accentuated the shortage of water.

During the year the manufacture of bricks on laboratory land was successfully started by Mr. Stenmark, the Laboratory Mechanic, and as many as 25,000 first grade bricks are now being produced monthly. As a result of this source of building materials *in situ* the work of reconstructing the old wood and iron boma buildings in brick was commenced on the 7th of August. At the close of the year one wing of the boma buildings had been completed and work is still in progress. This reconstruction work is being carried out in a very satisfactory manner by native staff from the Native Industrial Training Depot, Kabete, under European supervision; and the Department is greatly indebted to Captain G. J. Stroud, the Principal of the Native Industrial Training Depot, for his active co-operation and the assistance which he has so readily placed at our disposal. Working on these lines it has been found possible to erect excellent buildings in brick at a comparatively low capital cost.

Finance

The sanctioned expenditure for the year was £22,460; special warrants for an additional sum of £1,960 were sanctioned by Government in order to meet the cost of increased production of anti-rinderpest serum and other laboratory products. The revenue derived from the sale of sera, vaccines and laboratory products amounted to £4,946, an increase of £1,946 over the original estimate of £3,000. It will be seen, therefore, that the increased expenditure sanctioned was almost covered by a corresponding increase in revenue. The figure quoted is exclusive of revenue collected in respect of rinderpest double inoculations carried out by the Veterinary field staff, such collections being credited to Veterinary inoculation fees. The value of anti-rinderpest serum issued to the field staff at the scheduled rate of Sh. 2 per unit of 50 c.c. was £17,300, representing rather more than 50 per cent in excess of the amount for which the budget had originally be drawn.

The sale of hides realized £305, and £24 was derived from the sale of vaccinating materials.

Technical Routine

The following list shows the origin of the slides and specimens submitted to the laboratory for examination and report during 1936:—

SLIDES AND SPECIMENS SUBMITTED TO THE LABORATORY, 1936

Avians (Ducks)	4
,, (Fowls)	94
,, (Turkeys)	14
,, (Pea fowl)	1
Arsenic Tests	56
Bovines	5,144
Canines (Dogs)	83
,, (Jackals)	11
Caprines	11
Equines (Donkeys)	6
,, (Horses)	192
Felines	8
Human	2
Insects	3
Milk Specimens (Bacteriological)	28
Minerals	1
Miscellaneous Game	13
Ovines	245
Plants	11
Porcines	28
Rabbits	8
Snails	1
Ticks	10
Worms	13
Specimens unfit for diagnosis	293
Total	6,280

THE CLASSIFICATION OF THE DIAGNOSES IS AS FOLLOWS:

AVIAN (Ducks and Geese)	Total examined	4
Miscellaneous	2	
Negative	2	
AVIAN (Fowls)	Total examined	94
Fowl Typhoid	17	
Fowl Pox	1	
Miscellaneous	39	
Negative	37	
AVIAN (Pea Fowl)	Total examined	1
Negative	1	
AVIAN (Turkeys)	Total examined	14
Fowl Pox	1	
Fowl Typhoid	2	
Blackhead	1	
Negative	10	
ARSENIC TESTS	Total examined	56
Positive tests	30	
Negative tests	26	
BOVINES	Total examined	5,144
Anaplasmosis	314	
Anthrax	19	
Bacillary Necrosis	5	
Blackquarter	84	
Contagious Abortion Tests	1,902	
East Coast Fever	456	
Haemorrhagic Septicaemia	20	
Heartwater	16	
Paratyphoid	16	
Pleuro-pneumonia	4	
Rabies	1	
Redwater	125	
Small Piroplasms	160	
Trypanosomiasis	35	
Miscellaneous	129	
Negative	1,858	
CAMEL	Total examined	1
Trypanosomiasis	1	
CANINES (Dogs)	Total examined	83
Helminthiasis	14	
Tick Fever	18	
Trypanosomiasis	4	
Miscellaneous	1	
Negative	46	
CANINES (Jackal)	Total examined	7
Rabies	5	
Negative	2	
CAPRINES	Total examined	11
Pleuro-pneumonia	2	
Miscellaneous	3	
Negative	6	
EQUINES (Donkeys)	Total examined	6
Negative	6	

EQUINES (Horses) ..	Total examined	192
Anthrax	1	
Helminthiasis	75	
Trypanosomiasis	1	
Streptothricosis	2	
Ulcerative Cellulitis	7	
Miscellaneous	14	
Negative	92	
FELINES	Total examined	5
Rabies	1	
Negative	4	
HUMAN	Total examined	1
Rabies	1	
INSECTS	Total examined	3
Specimens	3	
MILK SPECIMENS ..	Total examined	28
Bacteriological Examination ..	28	
MINERALS	Total examined	1
Specimen	1	
MISCELLANEOUS GAME	Total examined	12
Helminthiasis in Oryx	1	
Negative	11	
OVINES	Total examined	245
Bluetongue	1	
Heartwater	20	
Helminthiasis	15	
Jaagziekte	5	
Lamb Dysentery	4	
Miscellaneous	29	
Negative	171	
PLANTS	Total examined	11
Specimens	11	
PORCINES	Total examined	28
Helminthiasis	1	
Swine fever	6	
Miscellaneous	3	
Negative	19	
RABBITS	Total examined	8
Miscellaneous	3	
Negative	5	
SNAILS	Total examined	1
Specimens	1	
TICKS	Total examined	10
Specimens	10	
WORMS	Total examined	13
Specimens	13	
SPECIMENS UNSUITABLE FOR DIAGNOSIS		293

CONTAGIOUS ABORTION TESTS

BOVINES	Total examined	1,902
Positive	227	
Doubtful	52	
Negative	1,623	

NUMBER OF RABIES BRAINS FROM KENYA COLONY EXAMINED DURING 1935 AND 1936

Year	Animal	Positive	Negative	Unsuitable for Diagnosis
1935	Dog	9	10	2
	Jackal	5	1	—
	Mongoose ..	—	2	—
	Total ..	14	13	2
1936	Dog	—	4	1
	Jackal	5	2	—
	Cat	1	3	—
	Mongoose ..	—	1	—
	Skunk	—	1	—
	Bovine	—	1	—
	Total ..	7	12	1

DISTRIBUTION OF POSITIVE CASES DURING THE YEARS 1935 AND 1936

Animals	North Kavirondo, includ. Kakamega	Burnt Forest–Eldoret	Soy–Hoey's Bridge	Moiben	Trans Nzoia	Moyale	Brains received from Tanganyika Territory for examiation
1935							
Dog ..	5	—	1	1	2	—	—
Jackal	1	2	2	—	—	—	—
1936							
Dog ..	—	—	—	—	—	—	—
Jackal	—	4	1	—	—	—	—
Cat ..	1	—	—	—	—	—	—
Bovine	—	—	—	—	—	1	—
Human	—	—	—	—	—	—	1

Dip Tests, Butter-Fat Tests and Toxicological Analysis

The number of dip samples analysed during the year was 379.

Fifty-six specimens of organs and ingesta were examined for the presence of arsenic. Of these 30 were positive and 26 negative. One sample of ingesta was examined for the presence of strychine with a positive result, and one batch of swabs was examined for cocaine with a negative result.

53,550 ml. of iodine solution were prepared and issued for use with dip-testing apparatus.

Under the Accredited Milk Recording Scheme of the Royal Agricultural and Horticultural Society of Kenya, 1,301 samples of milk were received and tested for butter-fat content.

Live Stock

The following table shows the number of live stock, other than small animals and poultry, which were shown in the laboratory stock ledgers during the year. These figures include animals sent by or purchased from stockowners for experimental purposes, or for use in the preparation of laboratory products.

Species	On Hand 1–1–36	Increase	Decrease	On Hand 31–12–36
Horses	29	10	10	29
Mules..	22	—	1	21
Cattle	855	1,066	1,037	884
Sheep	80	350	229	201
Goats..	7	201	178	30
Donkeys	1	—	—	1
Pigs	Nil	89	71	18
Buffalo	1	—	1	Nil

Laboratory Products

Anti-Rinderpest Serum

The stock of serum in hand at the commencement of 1936 was 8,195 × 50 c.c. units; the quantity manufactured during the year was 164,985 × 50 c.c. units, and 3,855 × 50 c.c. units were returned to the laboratory; a total of 177,035 units.

Issues of anti-rinderpest serum to the veterinary field staff, stockowners and other countries during the year totalled 175,965 × 50 c.c. units; thus there was a balance of 1,070 × 50 c.c. units on hand at the end of the year.

Production Table for 1936

An additional column has been inserted this year in the production table; this column estimates what would be the cost of purchasing the various biological products, at present manufactured at the laboratory, had they to be bought in the open market, that is from wholesale biological houses or from any alternative cheaper source. The total figure arrived at in this way does not, of course, bear any close relation to the actual revenue earned by the laboratory, since many of the products, e.g. pleuro-pneumonia vaccine, are issued free to stockowners in the Colony, whilst the return from anti-rinderpest serum is shown under the head Veterinary Innoculation Fees.

PREPARATION AND ISSUES OF VETERINARY PRODUCTS FOR THE YEAR ENDING 31ST DECEMBER, 1936

Products	Balance on Hand 31–12–35	Prepared at Laboratory	Returned to Laboratory	Issued to Field Staff and Stockowners	Issued to Other Countries	Total Issues 1936	Balance on Hand 31–12–36	Cost to Kenya of Quantities Prepared in 1936 if Purchased Overseas
								Sh.
Anthrax Vaccine (single spore) (Doses)	Nil	16,514	Nil	15,539	975	16,514	Nil	1,651
Blackquarter Vaccine .. .. „	„	81,720	„	79,250	2,470	81,720	„	50,666
Bluetongue Vaccine .. .. „	„	17,535	„	17,535	Nil	17,535	„	1,403
Colon Bacillosis Vaccine .. „	„	4,089	„	4,089	„	4,089	„	4,907
Contagious Abortion Vaccine .. „	„	806	„	806	„	806	„	1,008
Fowl Pox Vaccine .. .. „	„	8,093	„	7,813	280	8,093	„	971
Fowl Typhoid (K.F.D.) Vaccine „	„	26,057	„	25,237	820	26,057	„	2,606
Horse-sickness Vaccine.. (Courses)	„	2,112	„	1,507	605	2,112	„	10,560
Pleuro-pneumonia Vaccine .. (ccs.)	„	405,471 x 1cc. dos.	„	405,471 cc.	Nil	405,471	„	202,735
Paratyphoid Vaccine .. .. (Doses)	„	4,623	„	4,623	„	4,623	„	5,547
Paratyphoid Feed Vaccine .. „	„	2,944	„	2,944	„	2,944	„	3,533
Redwater and Anaplasmosis Vaccine .. .. .. „	„	369	„	369	„	369	„	369
Rinderpest Vaccine .. ..(Courses)	„	48,633	„	47,153	1,480	48,633	„	48,633
Serum Anti-Rinderpest .. (Doses)	8,195	164,985	3,855	175,365	600	175,965	1,070	461,958
Sodium Tellurite .. .. „	Nil	17,787	Nil	17,787	Nil	17,787	Nil	7,115
Trypanblue : Bovine .. .. „	„	261	„	261	„	261	„	26
Canine .. .. „	„	126	„	126	„	126	„	6
Tartar Emetic .. .. .. „	„	3,920	„	3,920	„	3,920	„	588
Wireworm Remedy Powder .. „	318,100	820,000	„	910,600	10,300	920,900	217,200	10,250
								814,532

Anti-rinderpest Serum ..	Field Staff	175,255 doses	(Units of 50 cc.)
	Stockowners	110 „	„
	Other Countries.. ..	600 „	„
	Total Issues, 1036 ..	175,965	

Research

Rinderpest

The amount of research on rinderpest carried out during the year 1936 was less than normal owing largely to the preoccupation of the Chief Veterinary Research Officer with other matters. The investigations of the Meat and Live Stock Inquiry Committee made considerable inroads on the time available for research, and in addition the Chief Veterinary Research Officer was acting Deputy Director (Animal Industry) from April to November. What research was undertaken was wholly directed towards the discovery of some method of attenuating the virus, with a view to the eventual production of a strain of sufficiently low virulence that it can be employed as an infective vaccine without any risk of occasioning mortality. It is, of course, essential that such a vaccine should be cheap to prepare and available in large quantities.

The object of the first series of experiments was to ascertain if rinderpest virus could be fixed as a neurotropic virus in any suitable domestic animal. Various methods were used in attempts to induce the virus to multiply in brain tissue. Mice were inoculated intracerebrally with mixtures of rinderpest virus and Rift Valley neuro-tropic virus, in the hope that the injury caused to nerve cells by the Rift Valley neuro-virus, and the infiltration of vessels with mesodermal cells might together supply conditions favouring the multiplication of the rinderpest virus. The procedure was varied by making use of an "O" strain of horse sickness neuro-virus which usually takes 6 days to kill mice, and inoculating the the rinderpest virus intracerebrally 3 days after the horse sickness virus. In only one instance was rinderpest virus recovered from the brains of inoculated mice 4 days after inoculation, this was in the first passage and the virus failed to survive a second inoculation period of the same length. After several repeat tests the method was abandoned.

A similar series of intracerebral inoculations was made in rabbits. A few of the intracerebrally inoculated rabbits died after intervals of from 6 to 10 days after inoculation, and the inoculations were carried in each case in series intracerebrally, but in no instance could the virus of rinderpest be demonstrated in the brain by inoculation of susceptible cattle. There was a suggestion that some specific disease affecting cattle was being transmitted in series in the rabbit brains, since two bovines inoculated subcutaneously with rabbit brains of the

fourth and fifth intracerebral passages showed a mild catarrhal condition accompanied by fever and loss of appetite in the first week after inoculation, but subsequently reacted normally to rinderpest: in one case by contact infection and in the other by inoculation.

In a series of attempts to infect rabbits by intravenous and intraperitoneal inoculations of bovine rinderpest virus the transient temperature reactions described by the workers in India and the Far East as characteristic of the infection were observed, and it was noted that the inoculated rabbits did not react similarly to a second inoculation of bovine virus. Tests carried out on susceptible cattle failed to demonstrate the presence of virus in the blood of apparently reacting rabbits except in one instance, where rabbits had been inoculated with the blood of a goat-passaged (54 passage) virus. In view of the experience of Edwards in India, the attempt to obtain an attenuated strain by serial passage in rabbits was abandoned for the time being.

It was next decided to attempt the adaptation of our stock rinderpest virus to propagation in goats, and then to see if a neurotropic strain could be produced by the technique evolved by Findlay for the virus of Rift Valley fever, that is by the intracerebral inoculation of a susceptible animal that has previously been passively immunized by an injection of immune serum. No difficulty was experienced in obtaining infections in goats by subcutaneous inoculations of our stock bovine virus, and of 23 animals used in the first 10 passages by this method every one died of rinderpest. However, repeated atempts to establish the virus intracerebrally in goats by the technique already described all met with failure, and apart from two deaths due to accidental bacterial infection of the brain, all the inoculated goats survived—an indication that the passive protection afforded by the serum had been adequate.

The subcutaneous series of passages in goats was continued, and by the end of the year 72 passages had been made. During the first 33 passages only one goat recovered out of 72 inoculated. From the 34th passage to the 40th passage the percentage of recoveries was much greater, 11 out of 27; but from the 47th to the 54th passage the mortality was 100 per cent. The mortality rate again fell from the 55th to the 62nd passage, 8 animals recovering out of 16, but from the 63rd passage to the 72nd it was 100 per cent of the animals actually infected; although here the first failures to transmit

were experienced, and one had to go back at the 70th passage twice to cold-stored material owing to failure to infect animals in the normal series.

From time to time the goat-passaged virus was tested for virulence in susceptible bovines, although for reasons of economy the tests were made only at infrequent intervals. Altogether nine cattle were infected from this series.

(*a*) Number of Goat Passage.
(*b*) Number of Bovine.
(*c*) Period between inoculation and death (in days).

(*a*)	XII	XVIII	XXIV	XXXI	XLI	XLIX	LIX	LXIX	LXXII
(*b*)	1574	1581	1573	1564	1580	2384	2376	2385	2372
(*c*)	9	8	8	7	8	9	22	16	14

The table which gives the period of survival of animals inoculated with material of the various passages indicates that some change in virulence might have occurred between the 49th and the 59th passages, but the number of animals inoculated is insufficient to warrant any conclusion being drawn. It can be stated, however, that the results with subsequent passages have borne out this indication, and that the first cattle to survive the inoculation were those inoculated with the 83rd passage, by which time a very definite degree of attenuation of the virus for bovines had been reached. The experiments are being continued, and the Muktesar goat virus is being obtained from India for comparison of its pathogenicity for African cattle with that recorded for Indian cattle.

With regard to the lesions observed in infected goats, involvement of the lung, with a virus type of bronchopneumonia originating in the anterior and accessory lobes, were prominent features post-mortem in the earlier passages. The lung changes were frequently extensive, and often complicated by a fibrous exudative pleurisy with several ounces of clear amber-coloured transudate in the pleural cavity. Lesions were rarely observed in the mouth or pharynx, and when present were never severe. The chief sites of lesions in the alimentary tract were the stomach and caecum, in which it was not uncommon to find large haemorrhagic patches and occasionally actual ulceration of the mucous membrane. Practically every animal showed a profuse mucous discharge from the nose and eyes, and all suffered from diarrhoea. Temperature reactions were irregular, but on the whole well marked.

The lesions in the first 6 cattle inoculated were the normal lesions of hyperacute rinderpest, the form which is regularly transmitted by our stock Kabete virus, which is of extremely high virulence for this species. In the last 3 animals which survived for 22, 16 and 14 days, the lesions were more chronic in form and much less marked than usual in the alimentary tract; the animal that survived 22 days finally died from metastatic infection in the liver and lungs, arising evidently from bacterial infection of gastric and caecal ulcers. None of these three animals had typical lesions of the nasal, conjunctival or buccal mucous membranes at the time of death, although all had shown these lesions earlier in the reaction period.

Malignant Catarrh

The research on malignant catarrh was continued and during the year a paper was published in the Journal of Comparative Pathology and Therapeutics (Transmission Experiments with Bovine Malignant Catarrh, R. Daubney and J. R. Hudson, Journ. Comp. Path. and Ther., XLIX, 63–89). The 1935 strain was taken through a further 14 passages in bovines in the 12 months, and the original rabbit strain through a further 21 passages, making totals of 18 and 28 passages respectively. A good deal of exploratory work was carried out with reference to the properties of the virus, its linkage to cells, presence in plasma, filtrability, survival *in vitro,* its immunizing power; and the syndrome in inoculated rabbits was compared with that of Borna disease. It is not proposed to discuss these experiments here in detail, since they are not yet complete, and in any event they will form the the subject of a paper in one of the scientific journals at a later date.

In the course of the year a new acute bovine strain, giving rise to the typical "head and eye" form of the disease, was recovered from affected cattle on a European farm in the Athi River District. The virus was successfully transmitted to cattle and rabbits, but was discarded after a few passages. Similar strains were recovered from affected cattle in the Kajiado section of the Masai Reserve.

Malignant Catarrh and Muthioko (*Turning Sickness*)

It has been observed in experiments (unpublished) made at Kabete that a simultaneous infection with the virus of malignant catarrh can modify the course of an east coast fever infection; and it was considered that possibly the malignant catarrh virus might be concerned in the etiology of *muthioko*

or turning sickness, which is really cerebral east coast fever in an immune animal. With this possibility in mind it was decided to obtain, if possible, animals recovered or partially recovered from turning sickness in order to test their susceptibility to the virus of malignant catarrh. Since, in our experiments with malignant catarrh we have failed to obtain definite evidence of the existence of a firm immunity in animals that have survived one infection with the virus, such a test could furnish information of value only if the recovered *muthioko* cases proved refractory to inoculation with the virus of malignant catarrh; in the event of their contracting the disease from inoculation it could not be assumed that they had not previously been infected.

Two recovered cows were obtained from the Veterinary Training Centre, Machakos. Cow 113 had been infected with east coast fever prior to 1933 and developed symptoms of *muthioko* in January 1936, but recovered partially, producing a healthy calf in April 1936. Cow 97 passed through an east coast fever infection prior to 1932, and developed *muthioko* about November 1934 and had almost completely recovered. These two animals were infected with malignant catarrh virus on September 28, 1936, and died in 40 and 41 days respectively, with typical lesions of malignant catarrh. There was, therefore, no demonstrable immunity to the virus. An interesting feature was that Koch's bodies, i.e. the schizonts of *T. parva,* could be demonstrated in smears made from the cerebral cortex of both animals after death. The parasites appear to have survived in the one case for 10 months and in the other for about 2 years, that is unless they were derived from tick infestation subsequent to recovery and before their removal to Kabete in September, 1936. That such a possibility of survival of the parasite in the schizont stage has been revealed is a matter for thought in connexion with the complete immunity to east coast fever of all adult animals coming from an enzootic area and the general assumption that this immunity is a sterile one—in contradistinction to the state of premunization which obtains after recovery from the initial infection with other protozoa of this group.

A Specific Transmissable Petechial Fever of Cattle

In the annual report of the Department of Agriculture for 1935 (p 146) a brief reference was made to an undescribed disease of cattle that had been observed on a farm near the laboratory. Since that time the disease has been found in other herds in widely separated parts of the country, and it

seems probable that it occurs almost everywhere in the highlands area. The mortality in natural outbreaks of the disease varies considerably but may be as high as 20 per cent of affected animals; in experimental infections, however, the death rate is inclined to be lower. In view of the fact that transmission is possibly effected by an insect vector, the disease bears some resemblance to bluetongue in sheep.

Economically the disease is of most importance in a dairy herd, since one of the most prominent symptoms is an immediate and striking drop in the milk yield of affected cows. Again, when recovery takes place it is usually slow, and animals may remain in poor condition for a considerable time. This feature was very apparent in a number of animals experimentally infected at the laboratory, and it has been noted in natural outbreaks.

Other symptoms are a high fever, and often swollen glands. In acute cases examination of the tongue reveals the presence of numerous small haemorrhages under the tip and along the sides of this organ. Very often an animal will look quite well one day and be found dead the next morning.

Post-mortem examination reveals extensive subcutaneous, submucous and subserous haemorrhages. The most striking lesion is an extensive subendocardial haemorrhagic infiltration in the left ventricle of the heart. The mucous membrane of the stomach and intestines shows multiple small haemorrhages, and in fact practically every organ in the body is similarly affected. The mucous membrane of the bladder is covered with petechial haemorrhages.

Mr. Danks has succeeded in transmitting the disease by blood inoculations. For the original transmissions large quantities of blood were used, but later it was found that a dose as low as 0.2 c.c. blood was capable of producing a typical reaction. Serial transmission has been carried through sixteen animals, with a noticeable decrease in mortality in the later passages.

Cultures of the organs and blood on various media under aerobic and anaerobic conditions have given uniformly negative results. Examination of blood, gland and spleen smears, sections of organs, and smears of the intima of the jugular vein have not revealed the presence of any parasites.

Inoculation of infective material by the subcutaneous, intraperitoneal and intracerebral routes into rabbits, guinea pigs, rats and mice have not produced any definite reactions.

Inoculations of infective material intratesticularly into guinea pigs and into the anterior chamber of the eyes of rabbits have also been without effect. The disease was, however, reproduced in a sheep and in dogs by subcutaneous inoculation of blood, but, as is also the case in inoculated calves, it does not produce any serious symptoms beyond a temperature reaction, and there is rarely any mortality.

Attempts to filter the virus have so far proved unsuccessful; but nevertheless the causal agent may well be a virus that is difficult to filter by the usual technique.

Immunity in recovered animals has been shown to persist for more than two years in adult animals, and is probably life long. On farms where the disease is enzootic, cases are rarely seen in adult animals born and reared on the premises, presumably because of an immunity arising from infection contracted in calfhood; whereas adult animals brought on to such farms from other areas are often highly susceptible.

Prophylactic vaccination has been carried out on a small scale, and there is evidence to show that some immunity can be produced by the serum-virus method (double-inoculation), or by three successive inoculations of formalized spleen vaccine.

Other diseases with which this affection has at times been confused are east coast fever and heartwater; the former, during life, because of the swollen glands, and the latter, post-mortem, because of some similarity in the distribution of the haemorrhages. These two diseases, however, are easily recognized, in the one case by gland-smear examination, and in the other by an examination of sections of brain. The absence of nasal and eye discharges helps to distinguish the condition from malignant catarrh.

Piroplasmosis of Pigs

During October smears were received from two gilts that had died after farrowing on a farm on the Mau, where it was the practice to herd the pregnant animals on pasture during the day and to bring them in for feeding about the middle of the afternoon. Both smears showed innumerable piroplasms in the red cells and very marked anaemic changes. The farm was visited and smears were made from a number of in-pig gilts that had been with those that died. One gilt was found that showed parasites and a bottle of her blood was brought back to the laboratory and inoculated by Mr. Hudson to two young pigs.

Both the pigs reacted and the parasite was sub-inoculated twice to other pigs. The disease was found to have an incubation period of 7–9 days. The symptoms and post-mortem lesions resembled those of redwater in cattle. Haemoglobinuria occurred and there was marked icterus.

In that the individuals of the double forms are spindle- rather than pear-shaped and in that small chromatin granules are often present in the ends remote from those in contact, the parasite agrees in morphology with *Piroplasma trautmanni* du Toit.

Ticks

Investigations into the distribution of all species of ticks in the Colony have been continued by Dr. Lewis and studies of the seasonal fluctuations of the more important species have been carried out during the year. The records, however, are insufficient to permit statistical analysis, and it is hoped to complete this work in the coming year.

The prominence given to the classification of *Hyalomma* species in continental scientific literature, and our discovery that *Hyalomma impressum* near *planum* is able to convey the parasite of east coast fever through the larval and nymphal stages, have prompted Dr. Lewis to collect, examine and breed ticks of this genus from different parts of the Colony and from other territories where theileriasis is known to occur.

It has been found that neither *Hyalomma aegyptium* nor *H. aegyptium impressum* is present in Kenya. The bont-leg ticks so far examined are *Hyalomma impressum transiens, H. impressum albiparmatum, H. dromedarii, H. impressum* nr. *planum, H. impressum rufipes, H. anatolicum,* and *Hyalommina lewisi.* In order to verify the validity of recent classifications, many of these ticks have been reared and it is proposed to publish the results of these studies next year.

Arising out of the programme of work on East Coast fever, and the distribution of its vectors, *R. appendiculatus* has been subjected to close examination.

Engorged females, larvæ and nymphæ have been exposed to a temperature of 4°C. for twelve days continuously. The females did not ovipisit while in the cold chamber, but after having been exposed to the cold for as long as nine days proceeded to lay eggs when transferred to an incubator (25°C.

to 28°C.). A longer exposure usually killed the female. In cases where oviposition did take place when the females were transferred to the incubator, most of the eggs hatched.

Exposure of engorged larvæ to a temperature of 4°C. arrested the moulting period and influenced the survival of ticks. The survival rate after exposure for various intervals was irregular, but there was a considerable drop after two and three days in the cold chamber. When subjected to a temperature of 4°C. for four days the survivals dropped in one experiment to 20 per cent.

Engorged nymphæ showed a greater resistance to cold than did the larvæ. After exposure for 5 days, and subsequent transfer to the incubator, nearly 100 per cent of nymphæ survived: after exposure for 10 and 11 days, only 14 per cent survived.

East Coast Fever.

Studies on the transmission of East Coast fever have been continued by Mr. Fotheringham and Dr. Lewis, who have also been able to compare the diseases caused by *T. parva* and *T. dispar* respectively. Particular attention was given to the ability of *R. appendiculatus* to transmit East Coast fever after batches of infected ticks had been subjected to different temperatures in the laboratory.

Theiler and Nuttall and Hindle studied the effect of low temperatures on the parasite within the tick and on the development of the tick itself. Theiler concluded that a temperature of 0°C. for half an hour daily for 21 days does not kill the parasite within the engorged nymphæ, nor interferes with its development. He observed that ticks kept at a low temperature moulted at a later date than controls kept at a normal temperature; but when the cooled ticks were placed on susceptible cattle, these animals contracted East Coast fever and died.

Nuttall and Hindle exposed infected nymphæ of *R. appendiculatus* to a temperature of 10°C. continuously for three weeks and, without warming them, placed them on a calf in a cold stall at ordinary outdoor temperature (approximately 8°C.). These ticks did not transmit East Coast fever. In a second experiment, another batch of infected nymphæ, that had been exposed to a temperature of 10°C. for three weeks, was subsequently kept at a temperature of 20°C. for four weeks and finally at 30°C. for two days. The nymphæ

were then placed on a calf and transmitted East Coast fever. Nuttall and Hindle concluded, therefore, that infected ticks are rendered non-infective by exposure to a temperature of about 10°C. for three weeks and that their infectivity is restored by subsequently warming them.

Observations in Kenya and other countries where East Coast fever exists seem to bear out the belief that the disease cannot exist for a prolonged period in a cold atmosphere at high altitudes and that the common vecting tick cannot survive and become established in such areas.

In view of the somewhat conflicting nature of the statements referred to and because of the practical bearing of the results, experiments on the influence of low and high temperatures on infective ticks were carried out at Kabete. Batches of infective nymphæ were exposed to temperatures of 4° to 6°C., 8° to 10°C., and 35° to 38°C. for periods of 7, 15 and 21 days. Other batches were subjected to alternating temperatures roughly simulating local diurnal variations of temperature. All ticks were placed on the ears of cattle immediately after they had been taken out of the cold or warm chambers. With the exception of two lots exposed to alternating temperatures and one lot exposed to a high temperature the ticks transmitted East Coast fever, all the animals dying of the disease. These results are in agreement with those of Theiler and differ from the findings of Nuttall and Hindle.

The experiments were conducted with infective nymphæ that had fed on a reacting beast in the larval stage and had been allowed to moult. It still remains to test the influence of temperature on engorged infected ticks prior to the moult.

Further experiments have confirmed the discovery recorded in the last annual report (p. 149), that a species of *Hyalomma* can transmit East Coast fever. The species now identified as *Hyalomma impressum* near *planum*, has again transmitted the disease both in the nymphal and adult stages.

Immature ticks of *Hyalomma* species have hitherto been thought to feed only on birds, small game and vermin; and indifferently, if at all, on cattle. Observations on the habits of several species reared in the laboratory have shown that larvæ will sometimes feed readily on cattle: at other times, for some obscure reason, the larvæ will not attach and feed on this host.

It has been suggested recently in the Veterinary Record that the virulence of East Coast fever may depend upon the site of attachment of the infecting ticks. Feeding ticks in the brush of the tail has been mentioned as a means of testing this hypothesis. In view of this, the result of feeding infective ticks on the tail at Kabete are of interest. Briefly, it has been shown that East Coast fever can be transmitted readily through the tail; and that the disease produced does not differ from that contracted naturally or from that produced by the usual experimental methods of transmission.

Theileria dispar *Infection*

Through the courtesy of Professor Edmund Sergeant a strain of *Theileria dispar* has been obtained for comparative study. Transmission has been effected through *Hyalomma mauritanicum* and the readiness with which the parasite may be transferred by blood inoculation has been confirmed. The ability of the local species of *Hyalomma* to transmit *T. dispar* has been investigated and subject to confirmation by future experiments it can be stated that *H. impressum* near *planum* in addition to being an experimental vector of *T. parva* can also transmit *T. dispar;* whereas *Rhipicephalus appendiculatus* does not appear to be capable of transmitting *T. dispar.*

There does not appear to be any cross-immunity between the diseases caused by *T. parva* and *T. dispar.* This is in agreement with the findings of Sergeant and his collaborators who compared *T. dispar* infection with East Coast fever transmitted by ticks obtained from South Africa.

Tsetse Flies

In response to requests made by the Europeans in the Sotik District, a tsetse fly survey was carried out in the western portion—Ol orokuti—of the Masai Reserve. It was believed that tsetses were rapidly spreading up the Mara and Mogor and that the proposed utilization of the Chepalungu Forest for native cattle might be responsible for bringing the fly on to the farms where it was planned to develop a dairy industry.

The survey revealed that *G. fuscipleuris* was present along the Mogor, Gori, and Oyani rivers; and that the fly dispersed over a considerable area along several small tributaries. *G. palpalis* was plentiful on the Mogor, but there was no evidence to indicate that it had advanced appreciably up the

river. *G. fuscipleuris* occurred with *G. palpalis* in the lower reaches of the Mogor, and *G. fuscipleuris* alone further up.

There seemed to be no cause for alarm, however; and recommendations were made to prevent possible spread into the Chepalungu Forest. The situation along the Mara appeared to be similar to that described in Dr. Lewis' publication on "Tsetses in the Masai Reserve," 1934. Collections of flies made along the Mara in 1914 have been presented to and examined by Dr. Lewis. In this collection are many specimens of *G. swynnertoni* and *G. pallidipes,* thus establishing the fact that *G. swynnertoni* is not a very recent invader of the area.

A survey was also carried out in the Ugenya and Samia districts of Central Kavirondo. *G. pallidipes, G. palpalis* and *G. brevipalpis* infest the lake shore from Port Victoria to a few miles below Sio. The permanent belt is largely confined to the foot of the Nzalagobe hills, but from pupa and puparia found in widely separated localities it is evident that the statements of the natives regarding the unsafe area for cattle are correct. The local natives benefit considerably from the cultivation of cotton, but they are unable to keep stock in the area and are thus compelled to purchase meat from other locations, sometimes far afield.

Lambwe Valley.

The experimental scheme for the control of *G. pallidipes* in the Lambwe Valley, South Kavirondo, has progressed satisfactorily. Unfortunitely, however, just as the practical aspect of the work was gaining some momentum, the grant from the Colonial Development Fund was exhausted. A further grant was made by the Local Native Council, South Kavirondo, under slightly modified conditions, and it was possible to carry on with much of the original plan and to prepare for future development.

During the year Commander Blunt was invalided home, and Mr. W. P. Langridge was appointed Tsetse Fly Overseer. Recognition is due to both these officers for the satisfactory progress made in the Lambwe Valley experiments.

In a report submitted to Government and the Colonial Advisory Committee, Dr. Lewis dealt with the whole scheme of experimental control in the Lambwe. Amongst many interesting points, he refers to the comparative value of the

traps used. One trap in particular—the Box-Screen trap designed by Commander Blunt—showed considerable promise; the catches were comparatively heavy in localities where the fly-density was high. None of the traps was very effective in areas of low fly-density. Even in those localities where *G. pallidipes* was abundant, there were periods when the traps caught extremely few flies. There were three useful types of trap, viz. Harris's, Blunt's, and Swynnerton's Single Screen trap with buttocks; no other design was at all effective. As stated in the report, the traps have not yet been tested fully, there is need for using bait or attractants in conjunction with them. It is also necessary to study more closely the period for which a trap may prove attractive to flies, and the efficiency of traps in reducing dispersal of the tsetse from a permanent "home".

It is of interest also to note that in Nyaboro, where flies were believed not to be very abundant and where traps consistently caught low numbers, hand-catching along routes where traps were situated, by patrols provided with hand-nets and hessian screen, revealed heavy localized infestations. Such patrols caught many more flies than did the traps, and even more than did patrols with bait-oxen moving along the same routes.

Another important investigation deals with the treatment of tsetse-infested bush. The programme of work is directed to controlling the fly without wholesale clearing of bush; it provides for isolation of blocks of bush and attacking the haunts of the tsetse by clearing the undergrowth only, and encouraging a thick sward of grass under the clean-trunked trees. In some sections, the trees also were thinned out. Due regard is given to the question of erosion. The barrier corridor above Morea Hill has been widened by another 300 yards; it now extends right across the valley from Theka to Kagana. On the Kagana side the area is now relatively safe for cattle to graze along the foothills from Kigoto to the area south of Morea. The corridor from Theka to the Gendu salt lick at the foot of the eastern scarp is near completion. From Kigoto across the valley to Kamathugi there is a corridor to separate Nyaboro bush from Riamakanga; and from Ugoro to Kisingiri there is another strip of clearing to cut off Otouk bush from Riamakanga. Not all the felled trees have been cleared away in the corridors, but where burning and stumping have been carried out the grass is growing rapidly.

The progress made in the reduction of tsetse in Nyaboro is shown in the following table, which also shows the monthly total and average (in brackets) catches in Riamakanga:—

Month	Nyaboro	%	Riamakanga	%
1936—				
April	1,433	(23·3)	11	(2·75)
May	4,746	(180·5)	44	(11·0)
June	3,491	(134·2)	15	(3·75)
July	852	(58·8)	8	(2·0)
August ..	—		—	
September ..	—		—	
October ..	3,679	(61·3)	204	(10·2)
November ..	2,733	(36·4)	177	(7·08)
December ..	871	(11·6)	65	(3·42)
1937—				
January ..	1,067	(11·9)	47	(2·93)
February ..	553	(5·7)	38	(1·58)
March ..	500	(4·6)	12	(0·44)

The increase of catches in Riamakanga from October, 1936, is due to more intensive catching by patrols.

It is thought that few flies now move across the Kigoto–Kamaguthi corridor to and from Nyaboro, and this may accelerate the eradication of the tsetse in Nyaboro bush. In the Nyaboro corridor the local natives have begun to cultivate shambas. This, and the advent of cattle to Kagana, will undoubtedly improve the prospects of any development in the next few years.

The Chemotherapy of Trypanosomiasis due to T. congolense.

The results of testing a number of compounds for therapeutic value in the treatment and prophylaxis of *T. congolense* infection are given in two tables. It will be observed that cures were effected with but three compounds, F995, antimosan and Surfen "C", and that with only the last could a cure be produced with a single dose. In addition to the drugs given in the table, tryparsamide, etoscol and antrypol have been tried without success.

We are indebted to Professor E. Fourneau of the Pasteur Institute, Paris, for the series of "F" compounds, which he had previously tested in the treatment of mice experimentally infected with *T. congolense;* to the I. G. Farbenindustrie of Leverküsen who made available supplies of Surfen "C" and to the British Drug Houses, Ltd., for a supply of antrypol.

TABLE I

EXPERIMENTS ON THE CHEMO-THERAPY OF T. CONGOLENSE INFECTION

Name	Chemical Composition	Dose	Animal Species	Result
F 727..	Sodium salt of 2–amino–4:4′–diphenyl–arsonic acid.	lg./155 lb. to lg./40 lb.	Cattle	Reduced numbers of trypanosomes in peripheral blood ; but did not sterilize.
F 682..	Sodium salt of 2:2′–diamino–4:4′–diphenyl–arsonic acid.	lg./206 lb. to lg./30 lb.	Cattle and Mules.	With doses of lg./100 lb. to lg./44 lb., parasites disappeared from circulation in 24–48 hours ; but returned after 2–8 days. Smaller doses did not sterilize. Largest dose, lg./30 lb., animal died eight days after inoculation and before parasites returned to circulation.
F 801..	Sodium salt of 4–amino–phenyl–1·2–diarsonic acid.	lg./160 lb. to lg./36 lb. Also 4 inoculations at 6 day intervals of lg./75 lb.	Cattle and Mules	Trypanosomes disappeared from circulation within 24–48 hours ; but returned again in from 1–28 days.
F 891..	Sodium salt of phenyl–1:2–diarsonic acid–4:5′–azo–2′–hydroxy-phenyl–1′–:4′–diarsonic acid.	lg./228 lb. to lg. 177 lb.	Cattle	Did not sterilize except in one case when trypanosomes disappeared within 96 hours ; but were absent for only one day
F 198..	Symmetrical urea of atoxyl (sodium salt of p–amino–phenyl arsonic acid).	lg./100 lb. to lg./50 lb.	Cattle	Smaller dose reduced number of trypanosomes in blood ; but did not sterilize. Larger dose caused trypansomes to disapper within 24 hours ; but they were only absent for one day.
F 309..	Urea of sodium salt of m–amino–o–benzoyl–m–amino–p–methyl–benzoyl–1–naphthylamino–4 : 6 : 8–trisulphonic acid.	lg./67 lb. ..	Cattle	Trypanosomes disappeared from blood within 48 hours ; but returned in 2–3 days' time.

EXPERIMENTS ON THE CHEMO-THERAPY OF T. CONGOLENSE INFECTION—(contd.)

Name	Chemical Composition	Dose	Animal Species	Result
Asuntol	Composition unknown, stated to be akin to naganol and F 309	lg./140 lb. ..	Cattle	Trypanosomes disappear within 48 hours; but returned after one day.
F 995..	Sodium antimony thiosalicylate ..	lg./250 lb. to lg./66 lb. Also 4 weekly inoculations of lg./44 lb.	Cattle	Smallest doses from lg./130 lb. downwards caused trypanosomes to disappear from circulation within 24–48 hours, and remain absent 3–9 days. Largest dose toxic causing death in 2 days. Four weekly inoculations of lg./144 lb. caused parasites to disappear 24 hours after first inoculation and they remained absent for 260 days. At this time animal inoculation experiments of blood were all negative. Animals cured. Two animals were given 3 weekly inoculations of lg./280 lb. and trypanosomes returned 30 days after the first inoculation. Four weekly inoculations of lg./120 lb. confirmed result obtained with 4 inoculations of lg./144 lb.
Merthiolate	Sodium ethyl mercuri-thiosalicylate ..	lg./158 lb. to lg. 136 lb.	Cattle	Disappeared within 96 hours and absent for one day in one animal. Did not sterilize in two other cases.
F 353..	Sodium salt of arsenomercapto–benzimidazol.	lg./180 lb. to lg./60 lb.	Cattle	Disappeared within 96 hours and absent for one day in one animal. Did not reduce numbers of trypanosomes in blood in two other cases.

EXPERIMENTS ON THE CHEMO-THERAPY OF T. CONGOLENSE INFECTION—(contd.)

Name	Chemical Composition	Dose	Animal Species	Result
Antimosan	Stated to be trivalent antimony + pyrocatechin–sodium–disulphonate.	lg./319 lb. to lg./100 lb. Four weekly inoculations of lg./235 lb. Four weekly inoculations of lg./142 lb., and 3 of lg./156 lb., followed by one dose of lg./106 lb.	Cattle, Mules and Dogs.	Single doses caused trypanosomes to disappear within 24 hours and remain absent for 6–11 days. The smallest doses given for four weekly inoculations allowed trypanosomes to return in 44 days. Larger repeated doses gave cures, trypanosomes remaining absent for 260 days. A dog *in extremis* was given four weekly inoculations and made a complete recovery.
Surfen C .. .. Various issues of this drug have been received. The later ones appear to be more effective.	Stated to be a quinoline derivative	Batch I .. lg./217 lb. and lg./204 lb.	Cattle	Trypanosomes disappeared from the circulation in 48 and 72 hours and remained absent for 96 days and 64 days respecl-ively.
		Batch II .. lg./312 lb. and lg./202 lb.	Cattle	Trypanosomes disappeared from circulation within 24 hours and remained absent at least 230 and 200 days respectively, when animal inoculat ons were negative. Cured.
	Intramuscularly	Batch III .. lg./300 lb. to lg./200 lb.	Cattle	One animal receiving lg./217 lb. was cured, trypanosomes remaining absent for 200 days. Four others showed return of parasites in 38–51 days.
		Batch IV .. lg./220 lb.	Cattle	Four animals treated and all remained free of trypanosomes. Horses, mules and dogs treated at the dose recommended by the makers, with excellent results.

EXPERIMENTS ON THE CHEMO-THERAPY OF T. CONGOLENSE INFECTION—(contd.)

Name	Chemical Composition	Dose	Animal Species	Result
Surfen C	Intravenously	lg./440 lb. and lg./220 lb.	Cattle	Small dose did not sterilize, Large dose circulation remained free of parasites for 110 days, the limit of observations. This dose produced temporary tremors and uneasiness. The strain of *T. congolense* used was suspected of being resistant to Surfen C. given intramuscularly.
Tartar emetic ..	Potassium antimonyl tartrate.. ..	lg./393 lb. .. Four weekly inoculations of lg./180 lb. and lg./150 lb.	Cattle	Single dose caused trypanosomes to disappear within 24 hours ; but they returned within 9 days. Repeated inoculations had to be discontinued, owing to death in the case of the large dose after 2 inoculations, and owing to the appearance of a large swelling in the neck in the other animal.
F 682 ∫ F 995 ..	.. ..	F 682 lg./65 lb. F 995 lg./145 lb.	Cattle	Trypanosomes disappeared within 24 hours ; but returned in 12 days.
F 801 ∫ F 309 ..	.. ..	F 801 lg./80 lb. F 309 lg./100 lb.	Cattle	Trypanosomes disappeared within 24 hours ; but returned in 8 days.
F 995 ∫ F 891 ..	.. ..	F 995 lg./150 lb. F 891 lg./75 lb.	Cattle	Trypanosomes disappeared within 24 hours, but returned 10 days later.
F 995 ∫ Merthiolate..	.. ..	lg./155 lb. of each drug and lg./115 lb. of each drug.	Cattle	Trypanosomes disappeared within 24 hours ; the animal died 4 days later. The other showed a return of parasites 15 days later.
F 309 ∫ Asuntol ..	.. ..	F 309 lg./67 lb. Asuntol lg./20 lb.	Cattle	Trypanosomes disappeared within 24 hours ; but were absent for 6 days only.
F 801 ∫ F 995 ∫ F 309	.. ..	F 801 and F 995 lg. 195 lb. F 309 lg./97 lb.	Cattle	Trypanosomes disappeared within 24 hours ; but returned 15 days later.
F 891 ∫ F 995 ∫ F 309	.. ..	F 891 and F 309 lg./55 lb. F 995 lg./110 lb.	Cattle	Trypanosomes disappeared within 24 hours ; but returned 26 days later.

TABLE II

PROPHYLACTIC EXPERIMENTS

Drug	Chemical Composition	Dose	Animal Species	Period between Dosing and Inoculation of Trypanosomes	Results
Surfen C	A quinoline derivative	lg./572 lb. ..	Cattle	3 and 4 weeks	All animals showed parasites within 3 weeks of inoculation of infected blood.
		lg./112 lb. ..	Cattle	3 weeks ..	Parasites absent 26 days after inoculation of blood. This was a recent batch of the drug.
Antrypol	Symmetrical urea of the sodium salt of m–amino–o–benzoyl–m–amino–p–methyl–benzoyl–1–naphthylamino–4:6:8–trisulphonic acid.	lg./220 lb. ..	Cattle	3 weeks ..	Animal reacted to inoculation.
Surfen C + Antrypol	.. ..	lg. of each drug/ /220 lb.	Cattle	3 weeks ..	Parasites were present on the 35th day after inoculation.

All cattle were infected with strains of *T. congolense* which have been maintained in rabbits. An animal is not considered to have been cured until it has been successfully reinfected.

Among control animals inoculated the following natural recoveries have been noted:—

Bovine 7869 was inoculated with infected blood on October 16th, 1935. Trypanosomes were present in the blood from October 24th to December 2nd of that year; but disappeared from the circulation between the last date and January 29th, 1936. The blood was still free from parasites on May 5th.

Goat 433 was inoculated with infected goat blood on September 13, 1935. Parasites were present in the blood from September 25th until December 2nd, but had disappeared by January 6th, 1936. No parasites were seen in the blood until April 5th, 1936, when a sample of blood was inoculated to small animals without transmitting trypanosomes.

Pig 1582 was inoculated with the same blood as goat 433. Parasites disappeared from its blood between October 14th and November 1st, and had not reappeared by March, 1936, when small animal inoculation was effected with negative results.

Two animals appeared to show evidence of strains becoming fast to Surfen "C".

Bovine 9007 received a full dose of Surfen "C" on June 10th, 1935, and was taken as cured on December 5th. It was reinfected with *T. congolense* and reacted. A full dose of Surfen "C" was given on January 29th, 1936. Trypanosomes returned to the circulation in 43 days. Another dose of Surfen "C" was given on March 13th and trypanosomes returned after 33 days. Treatment was again repeated on December 6th, 22 days later parasites reappeared in the circulation and the animal died.

Bovine 8819 was treated with Surfen "C" on July 10th, 1935, and was apparently free from parasites on November 5th. It reacted to reinoculation and was treated with Surfen "C" on January 29th, 1936. Trypanosomes returned to the circulation after 43 days. Thirty-three days after a further treatment on March 13th trypanosomes were again found in the blood. Later

they could not be found in wet smears, but when the animal reacted to transmissible petechial fever, its blood transmitted trypanosomes to two other animals.

Sheep Scab

A small experiment on the dipping of scab-infested sheep was conducted at the Experimental Station, Naivasha. The dips used were proprietary brands of an arsenic and a lime-sulphur compound.

The experiment was designed to test the practicability of a carefully planned scheme involving the separation of flocks, examination of all sheep, hand-dressing, marking and dipping. At the time the farm was not efficiently fenced, and the flocks were moved off the farm and back again several weeks after the last (third) dipping.

Despite the care taken in the treatment, scab re-appeared in the flocks three months afterwards; and it is believed that the recrudescence was due to the movements referred to.

Observations on the temperature of the dips were made during the mornings when the sheep were dipped. At 6.30 a.m., before dipping commenced, the temperature of the dip was 54°F.; at 9.30 a.m., when many sheep had been dipped, the temperature was 66°F., and it remained at approximately that temperature until 10 a.m. With the exception of a few lambs, all sheep were retained in the tank for not less than two minutes; many were kept in the dip for three minutes and four and a half minutes with no ill effect.

Native sheep in poor condition were affected more severely by the lime-sulphur than by the arsenic compound dip. Woolled sheep suffered no appreciable ill-effects, with one or two exceptions. The mortality was low, and was attributed more to the condition of individual animals than to any specific effect of the dips. After the first dipping, the mortality was 0.66 per cent (represented by 6 lambs dipped in arsenical dip, and two adults in lime-sulphur); the mortality after the second dipping was 0.75 per cent (4 lambs and 1 adult in arsenic and 4 adults in lime-sulphur), and after the third dipping 0.09 per cent (1 adult dipped in lime-sulphur).

The experiments were incomplete, in that it was not possible to control the movements of the sheep at that period.

Further studies of the incidence of sheep scab are being conducted at the Veterinary Research Laboratory with a view

to determining the seasonal fluctuations, if any, which occur under known climatic conditions.

A preliminary review of remedial measures has been published, and another contribution on "Sheep Scab in Kenya Colony" has been submitted in the *East African Agricultural Journal.*"

Lamb Dysentery and Entero-Toxaemia

During the year several outbreaks of lamb dysentery and entero-toxaemia in older lambs came under observation. The most severe outbreak of lamb dysentery and the heaviest mortality from entero-toxaemia occurred on adjoining farms, the lamb dysentery outbreak preceding the entero-toxaemia by a couple of months.

Typical lamb dysentery was seen in Kenya as long ago as 1928, but outbreaks in the intervening years have been small, and generally confined to high country; and the disease has only made its appearance towards the end of each lambing season. In the last two years the incidence of the disease has been more widespread; and although it has been confined to the end of the lambing season in most cases, the disease was diagnosed for the first time in 1935 in the drier areas of Elmenteita. Finally in 1936 a serious outbreak with heavy mortality was recorded on the Aberdares.

The existence of entero-toxaemia or pulpy kidney has been recognized for about 8 years in the Colony, but the two farms chiefly affected are so remote that it has not been possible to obtain supplies of satisfactory material for bacteriological work.

In 1936 lamb dysentery was diagnosed on several farms and *C. Welchii* was isolated from sick and dead lambs. Bowel contents were characteristically toxic after filtration for mice, but most of the strains of *C. Welchii* isolated proved not to be highly toxigenic. The same character was noticed in the strains isolated from cases of entero-toxaemia in which the bowel contents had proved toxic. In view of the tendency of the disease to spread it was decided to manufacture a vaccine of the formalized whole culture (i.e. bacteria and ana-toxin) type, and a request was addressed to the Director of Veterinary Services, Onderstepoort, for our immediate requirements in vaccine and for South African type strains. Dr. du Toit very kindly supplied us both with vaccine and with the type strains from which the vaccine was prepared, at the same time remarking that the type strains were all of

British origin, because although the existence of both diseases in South Africa was undoubted, the strains of *C. Welchii* that they had isolated had so far all proved to be either atoxigenic or only feebly toxigenic.

This agreed with our own experience up to date, but later in the year Mr. Hudson recovered highly toxigenic strains from the serious outbreak of entero-toxaemia to which reference has already been made. These toxins will be typed, and during 1937 it is intended to type as many strains as can be collected from outbreaks of the two diseases, in order to make certain that the *C. Welchii* types affecting sheep in Kenya conform to those known elsewhere, and that their toxins are completely neutralized by the standard types of antitoxin.

Infectious Mastitis

The increasing incidence of mastitis in cows is a source of considerable anxiety to the Department and to the owners of the affected herds. Numerous samples of milk have been received by Mr. Danks for bacteriological examination. He considers that some of the samples had been too long in transit to give a true picture of the bacterial flora of the affected udder, but from the various samples all four groups of streptococci were isolated. Groups I and III appear to be the more prevalent. A diptheroid organism has also been isolated in pure culture from a very virulent form of the disease, and other organisms such as staphylococci, diplococci and *B. coli* have been found on occasion.

Tests have been made in some affected herds with brom-cresol-purple and brom-thymol-blue test papers with the object of detecting carriers, and advice has been given on hygienic methods of controlling the disease.

On a farm where the disease was very prevalent whole-sale vaccination of the herd was undertaken. The vaccine used was a formalized serum-broth culture of streptococci isolated from that particular herd. The owner reported very satisfactory results, stating that further spread of infection had been prevented. Acute cases of the disease have been treated with a similarly prepared autogenous vaccine, in many instances with apparently good results.

These clinical reports from farmers do not accord with the findings of the majority of workers in this field, who do not consider that vaccination has any curative or preventive value.

Contagious Abortion

There were 1,902 samples of blood tested at the laboratory this year, of which roughly 15 per cent were either positive or doubtful. Advice has been given to many farmers who are desirous of eradicating the disease from their herds.

The typing of strains of *Brucella* from Kenya and neighbouring countries has been continued by Mr. Danks. It is of interest to remark that in Kenya only one type of organism, *Brucella abortus,* has up to date been associated with disease, either in man or animals; while in the neighbouring territory of Tanganyika both *B. abortus* and *B. melitensis* occur. The third type, *B. suis,* has not been recorded from East Africa.

Calf Diseases

Desultory investigations were continued into the etiology of the infectious calf pneumonia, mentioned in the last annual report (p. 148). In advanced cases of the disease *Corynebacterium pyogenes* was found to be the most frequently isolated organism, at times being in pure culture; but more commonly being in association with bipolar organisms of the *Pasturella* type. These bipolar organisms were not, however, typical of *P. boviseptica* either in cultural characters or in pathogenicity. Occasionally very early cases of pneumonia were seen, in which lesions were confined to the anterior lobes and in which the changes hardly amounted to more than the atelectasis commonly associated with the pure virus infection of swine influenza. Frequently the lungs in such cases proved on examination to be bacteriologically sterile.

Attempts to transmit the disease by intranasal and intratracheal inoculation of cultures and/or suspensions of affected lung tissue were unsuccessful; but it is intended to repeat these experiments with younger calves.

During February an outbreak of what was probably *Salmonella typhi-murium* infection occurred on an estate near Naivasha in calves 7 to 14 days old. A diphtheritic lesion was present with great constancy in the caecum and colon of the affected animals. A *Salmonella* that fermented inosite was isolated and the disease was reproduced by drenching young calves with cultures. Although serological typing of the organism has not been completed, preliminary tests with H-specific Oxford sera show that if the organism is not *S. typhi-murium,* it is a very closely related, undescribed form.

A formalized autogenous vaccine was prepared, the use of which together with the adoption of suitable hygienic measures soon suppressed the outbreak.

Nakuruitis

According to the Masai the year 1936 was one of the worst nakuruitis years that have occurred within living memory. Early in the year reports from settlers indicated that the feeding of iron oxide, recommended after the results of the Rowett Research Institute's experiment of 1926–1928 became known, was failing to prevent the onset of the disease in the Nakuru District.

In view of recent work on enzootic marasmus in Australia it was decided to try the effect of feeding cobalt nitrate. A controlled experiment on sheep on a farm in the Naivasha District was instituted. While all the animals in this experiment gained in weight, those receiving cobalt nitrate showed a decidedly better recovery in red-cell counts. In the Nakuru–Njoro area where many of the farmers obtained supplies of cobalt nitrate for themselves, cobalt was also fed to cattle. Although no controls were kept, the improvement in the cattle was such as to suggest that the cobalt was having a marked effect. A large controlled experiment on cattle is now in progress; but in view of the seasonal incidence of the disease it will be some time before a definite opinion can be formed as to whether the feeding of cobalt nitrate is all that is required to prevent the onset of the disease, and to cure severely affected animals.

Report of the Naivasha Experimental Station Farm

The year under review has been more promising from a stock-farming point of view than any since the depression began. The prices obtainable for stock tended to rise throughout the year, and the stock was easier to dispose of. Export of cattle to Abyssinia helped the beef market, and there was also a better demand locally for wethers and breeding stock. There was also a greater demand for stock (particularly fat stock) from natives.

Kenya wool rose during the year from 12d. per lb. to approximately 18d. per lb. on the London market, and there was a rise also in the price of butter-fat.

Pigs were again unremunerative, and the effect of a slight rise in price was counteracted by the increase in the price of foodstuffs.

Cattle.—The cattle at the station were maintained as a dairy herd, but all calves are now being reared and it is hoped that eventually some revenue will be derived from the sale of steers. Poor yielding cows are being culled from the dairy herd and will be put to a beef bull. For this purpose a Hereford bull was imported from England and use will also be made of Aberdeen-Angus and Sussex bulls imported from Rhodesia by the Chief Veterinary Research Officer.

A Friesian bull calf was purchased and will eventually be used as a sire for part of the dairy herd. A yearling Ayreshire bull was also purchased early in the year and is now being used.

The herd was tested for contagious abortion and there was only one doubtful reactor.

Sheep.—The sheep have again proved more profitable than cattle and pigs. They were shorn twice during the year. One half of the clip was sent to the Continent and the other to London. A relatively better price was obtained on the London market where a much quicker sale was obtained. In future it is intended to send all the wool to London, and it is expected that the undivided clip will obtain a much better market.

The system of recording the weight of the fleeces of all the breeding ewes has been continued.

Mr. Begg very kindly purchased for the Experimental Station one stud Merino ram and 20 stud Merino ewes in South Africa. These sheep arrived in May and have done very well. The ram and 9 ewes were exhibited at the Nakuru Show of the Royal Agricultural and Horticultural Society of Kenya in June, the ram being placed third in his class and the ewes winning the respective classes in which they were entered. When shorn in June the ewes averaged $16\frac{3}{4}$ lb. of wool for a 12 months' growth.

It has been noticed that in several of the ewes the character of the wool has changed since May. The fleece in some cases appears to have deteriorated and in others to have improved.

One hundred Blackhead Persian ewes were purchased in the Northern Frontier Province in May. They did very badly at the Experimental Station and about 50 per cent died. No actual disease could be discovered, and the cause of the mortality was thought to be simply the change from the arid

conditions of the Northern Frontier to the lush grazing at Naivasha. One hundred Masai ewes were also purchased at the same time and coming from a type of country very similar to Naivasha, they have done very well. It is intended to cross both breeds of ewe with pure-bred Merino rams and to study the fleece in successive generations.

After shearing all the sheep were dipped in home-made lime and sulphur solution, and it appears that sheep scab has been completely eradicated. The routine measures of dosing for wireworm and de-ticking were carried on throughout the year.

Pigs.—With the exception of 2 gilts sold for breeding purposes all pigs reared were disposed of as baconers. Most of the foodstuffs had to be bought and the pigs showed only a very small profit.

General.—The rains continued throughout the year and there was abundance of grazing.

Two mowing machines were engaged in cutting grass whenever conditions were suitable, and a number of stacks of hay were made. Two small pits of young grass and molasses silage were put down, but have not yet been used. An attempt was made to plant up all the cultivated land with Napier grass; but the heavy rains in May brought the Melewa River down in flood and all this land was swamped, in some places the standing water was as deep as 4 feet. The flood killed off part of the lucerne and two acres of Rhodes grass. Later the weather was so dry that it was difficult to get the Napier grass established.

Paddocks have been erected around the Laboratory and a start was made with the erection of stone buildings to house experimental animals. Repairs to fencing and buildings were also carried out.

Experimental Station Laboratory

Fertility in Cattle and Sheep

Cattle.—The breeding records of the Experimental Station herd of grade cows have been examined. These records, which refer to approximately 160 grade cows and heifers, cover a period of 6 years. The breeding record of the herd over this period, which included three years of a severe drought, was satisfactory. The calving interval was 15 months, which if 12 months be taken as the standard interval represents a breeding efficiency of 80 per cent. The

average interval between calving and fertile service was 111 days; it was shortest for cows calving in September–October. Most calvings took place in September–October, followed by November–December with the next highest average. May–June had the smallest percentage of calvings. There was an increase in the percentage of cows calving in September–October with successive calvings; thus 8.9 per cent of first calvers calved in September–October and 32 per cent of fifth calvers calved in these months.

Abortion was not a serious source of loss to the herd during the years covered by the records. There were 5.8 per cent of abortions out of 534 known pregnancies, and of this percentage only 3.4 per cent occurred in reactors to the contagious abortion test. Of the cows that aborted 4 or 13 per cent became permanently sterile. The recurrence of heat after abortion was delayed in the majority of cases and the calving interval lengthened.

The fertility of bulls used during these 6 years was estimated on the percentage of fertile services for cows with good breeding records. 62.8 per cent of the services of 5 bulls on the Experimental Station Farm were fertile. Records of the fertility of bulls were obtained from 6 other farms. It will be seen from the following data that there is considerable variation in the fertility of bulls on different farms and that the performances are on the whole very unsatisfactory.

Farm	Number of Bulls	Number of Services	Fertile Services	
			Number	Percentage
Experimental Station	5	433	272	62·8
2	4	186	100	53·8
3	5	459	204	44·4
4	11	1,255	379	30·2
5	5	529	141	26·7
6	11	1,950	278	14·3
7	2	252	26	10·2
	43	5,064	1,400	27·6%

Sheep.—It was found that at the most only 63 per cent of high grade Merino ewes held to a single insemination. In order to discover if this was due to faulty technique or to the sheep themselves, two experiments were carried out to determine the fertility (*a*) in a group of 100 ewes that were hand-served, i.e. had one service each, and (*b*) in a group

of 309 ewes with which the rams were allowed to run in the usual way. 67 per cent of group (*a*) and 73 per cent of group (*b*) lambed. In another group of nearly 900 grade Corriedale ewes, hand-service resulted in 56 per cent holding to the ram, but when the rams were kept in this Corriedale flock for about 9 weeks the percentage of ewes that lambed was 81. The fertility of 7 pure-bred Merino rams on the Station was found to be as follows:—

Ram	Number of ewes served	Number of ewes lambed	Percentage of ewes lambed
			%
701 ..	0	0	0·0
714 ..	11	9	81·8
3237 ..	26	20	76·9
3062 ..	6	6	100·0
709 ..	2	0	0·0
703 ..	40	26	65·0
A ..	11	6	54·5
	96	67	63·5%

Oestrous Cycle in the Cow and Ewe

Cow.—It had been found previously that the duration of oestrus in Zebu cows was very short, but it was uncertain whether this was a characteristic of the race or whether it was to be attributed to nutritional factors, because the pasture which formed the sole food of these cows was deficient in protein and phosphorus. Accordingly, observations on the periodicity and duration of oestrus in Zebu cows have been repeated at the Experimental Station where the pasture compares favourably with European standards. Another group of cows under parallel observation was fed a supplementary ration of concentrates and minerals. So far, there is no difference in the duration of oestrus in the two groups. The duration of oestrus in both these groups is slightly longer than that previously recorded, which averaged 1½ hours, but it is considerably less than that given for European stock. It appears then that Zebu cows normally experience a shorter period of oestrus than cattle in Europe. The duration of oestrus in grade cows appears to be intermediate between that of Zebu and pure-bred European cows.

The relatively short duration of oestrus in Zebu and grade cows means that a certain number of heat periods will be missed when the practice is to put the bulls with the cows twice a day at milking time; and since the signs and intensity

of short oestrous periods are not well marked, the detection of a cow on heat is all the more difficult. The solution of the problem, therefore, is to keep "teaser" bulls with the herd all the time to pick out cows on heat, which can then be brought to the bull for service.

Sheep.—Observations on the periodicity and duration of oestrus in grade Merino, Masai and Blackhead Persian ewes are in progress. Oestrus in the Merino ewe lasts 6–48 hours and in the native sheep the duration is somewhat longer. In all these sheep oestrus recurs on an average every 16–18 days.

Ovulation in the Ewe

The time of ovulation in the ewe has been studied by examining the ovaries under Nembutal anaesthesia. The experimental ewes were run with "teaser" rams and the relation of ovulation to the beginning and end of heat determined. The earliest time of ovulation noted was 27½ hours after the beginning of heat. None of the ewes examined while still on heat had ovulated. When oestrus lasts for longer than approximately 25 hours ovulation seems to occur shortly after the end of heat. One ewe, for example, was examined 33 minutes after the end of heat and the follicle was just on the point of rupturing. Other ewes with oestrous periods shorter than 20 hours do not, however, ovulate within a short time after the end of heat. Two ewes that were on heat for 19 hours had not ovulated 4½ hours after the end of heat. It seems that while a certain minimum period must elapse after the beginning of heat before ovulation can occur, ovulation occurs shortly after the end of heat when the heat period is long.

The effect of a Supplementary Ration on the Length of the Interval between Calving and the Recurrence of Oestrus

No effect of feeding a supplementary ration on this interval has been observed.

Artificial Insemination

202 grade Merino ewes were artificially inseminated during December, 1935, to February, 1936. The results of this experiment are as follows:—

Number of inseminations	1	2	3	4
Number of ewes inseminated	202	91	34	17
Number of ewes "settled"	111	57	(17)	—
Percentage of ewes "settled"	54·9	62·6	—	—

The number of ewes that "settled" (as indicated by those that did not return to the ram) was 168 or 82.3 per cent for the first two inseminations. 150 or 74.3 per cent of the ewes lambed or were found to be pregnant on post-mortem examination, and the total number of live lambs, dead lambs and foetuses was 188 (93.1 per cent).

Further experiments were carried out during June–August, 1936, on grade Merino ewes. These experiments are divisible into two main groups (*a*) on a flock of 3,102 ewes and (*b*) on a smaller flock of 200 ewes.

(*a*) The details of this group are as follows:—

Number of ewes inseminated	..	3,102
Number of ewes lambed..	..	1,367
Percentage of ewes lambed	..	44·1

4,897 inseminations were carried out on these 3,102 ewes, which gives an average of 1.6 inseminations per ewe.

(*b*) Only 25 per cent of the Experimental Station ewes lambed.

The unsatisfactory results of experiments (*a*) and (*b*) are considered to be due to the use of unsatisfactory rams. It was intended to use pure-bred Merino rams that had been recently imported. When the experiment began none of the imported rams would serve so rams which had been on the Experimental Station for some years and which were known to be indifferent sperm producers had to be used. An illustration of this is afforded by the two groups of ewes that were inseminated using the dilutor GPS_2 in a dilution of $\times 8$. In the first group in which the Experimental Station rams were used 17.2 per cent of ewes "held". In the second group other rams were used and the percentage of ewes that held was 54.0. Dilutors GPS_2 and GPS_3 were tested in dilutions of from $\times 2$ to $\times 32$ but the results were inconclusive since unsatisfactory rams were used.

An attempt was made also to use a recently imported yearling Southdown ram for artificially inseminating 200 ewes. The ram was not sexually vigorous and the sperm produced was small in quantity and poor in motility. Only 5 per cent of lambs resulted from this experiment. Another Southdown ram of similar age and imported at the same time produced 20 per cent of lambs at the Veterinary Research Laboratory, Kabete, when allowed to serve normally. Further reference will be made later to this "importation" sterility in rams.

To be of any practical value in Kenya artificial insemination will have to be done by the farmer himself. One farmer who was instructed in the method began inseminating a flock of approximately 800 Corriedale ewes in November and it appears that the results will be satisfactory.

The best results from artificial insemination of sheep will be obtained by having a breeding season of, say, 9 weeks duration and by inseminating every ewe that returns to the ram during this period.

The greatest difficulty in applying artificial insemination to sheep in Kenya at the moment is finding suitable rams, i.e. rams that produce dense highly motile specimens of sperm with only a small percentage of spermatozoa of abnormal morphological features. When such a ram is available good results should be obtained from artificial insemination.

Collection of Ram Sperm.—All the sperm used for artificial insemination has been collected with the artificial vagina (Walton's pattern), which is a very satisfactory method. The method of inducing ejaculation by electrical stimulation (Gunn) has also been investigated. This method obviates the trouble of preparing the artificial vagina. The sperm can be collected directly into a test tube and a purer specimen obtained. Ejaculation can be induced with a stimulus of 30v.90ma.; but after a time the ram becomes used to this small current and will not ejaculate. 30v.160ma. (with the electrodes in position in the ram) has proved satisfactory. 702 specimens of ram sperm were collected during the year.

Volume of the Ejaculum in the Ram.—The volume of the ejaculum is greater when the ram is stimulated electrically than when the artificial vagina is used.

Number of Rams	Number of Ejaculations	Average volume of sperm in mls.	Method
9 ..	385	0·63	Artificial vagina.
6 ..	27	1·34	Electrical stimulus.

Storage of Ram Sperm.—Some experiments have been made on the preservation of sperm in vitro. The preservation of ram sperm is only of importance for transport of sperm over a distance. On sheep farms in Kenya there are usually

sufficient ewes on heat at any one time to allow of full utilization of all available sperm. The effect of temperature and dilution on storage of sperm are being studied.

Artificial Insemination of Cattle

During the period under review 130 cows and heifers on the Experimental Station have been artificially inseminated. The collection of sperm was easily effected with the artificial vagina (Walton's pattern). In the majority of cases the sperm was used undiluted; but gluco-phosphate and tartaric dilutors have also been tried out. The results obtained up to date indicate that this method will be as satisfactory as normal service.

Volume of the Ejaculum.—186 specimens of bull sperm were collected during the year and the average volume of the ejacula was 5.5 ml.

Sterility.—Reference has already been made to the poor fertility of bulls in some herds in Kenya. The reproductive performance of 68 bulls has been investigated and a correlation between the percentage fertility and sperm production has been attempted. The bulls were tested with cows on heat and the artificial vagina was used for the collection of sperm. The following points were noted:—

> Ability and keenness to mate, motility and density of the ejaculum and the morphological characters of the spermatozoa.

For the purposes of comparison between different specimens of sperm a scale representing degrees of motility and density is used.

Of the 68 bulls only 22 or 32.4 per cent produced sperm of high motility and density, 16 or 23.5 per cent produced sperm of moderate motility and density and 5 or 7.5 per cent produced sperm of poor motility. 15 or 22.1 per cent produced no sperm, and 11 or 16.2 per cent would not serve. A certain number of bulls produced a high percentage of spermatozoa with abnormal morphological features. On the whole, on the 8 farms the results of the sperm examination corresponds with the breeding records.

A number of sterile bulls or bulls with low fertility showed the typical induration and enlargement of the testes and epididymis that has been associated with outbreaks of vaginitis in Kenya. Other bulls that produced unsatisfactory sperm showed no clinical abnormalities.

The commonest cause of delay in getting a cow in calf again after a calving is absence of heat, the interval between calving and first oestrus is affected by the season of the year, and probably also directly by nutritional conditions when these are extremely unfavourable. In one herd with a history of absence of oestrus the ovaries of the cows were not functioning. This was attributed to old age and poor condition of the cows. The inorganic blood phosphorus in these cows was normal. Other cases of sterility in the cow have been associated with uterine infection and ovarian cysts.

Sheep.—Knowledge of the breeding efficiency of sheep can only be gained under ordinary conditions from the percentage of lambs born or marked at "tailing". On the Experimental Station all the breeding ewes have been ear-tagged and individual records can be followed.

Four per cent of a group of ewes that were hand-served did not come on heat during the last tupping season. Oestrus in the ewe appears to be easily upset. Shearing and double dipping caused cessation of oestrus in a group of experimental ewes. The recurrence of oestrus after a non-fertile service is apt to be irregular; some ewes may go well over 3 weeks before coming on heat again. About 10 per cent of ewes that held to the ram subsequently did not lamb. This may have been due to abortion, death, and resorption of the foetus, or merely to irregularity in the time of recurrence of oestrus. On the other hand oestrus does not occur once or oftener during pregnancy in the ewe.

Three percent of rams is the usual allowance for tupping in Kenya, and infertility in a ram can only be detected when the ram is used for hand-service or artificial insemination. A number of rams have been examined in connexion with artificial insemination and the majority of them have produced sperm of poor motility and density and have been quite unfit for use.

A form of temporary sterility has been noted in sheep imported into Kenya from South Africa and England. Both ewes and rams are affected but the rams seem to recover sooner than the ewes. Of 20 pure-bred Merino ewes which arrived in Kenya on May 21st, 1936, only one had lambed by the beginning of December, though a ram was with them all the time. By the end of the year several more had lambed and others are probably in lamb. These lambs were sired by

a pure-bred Merino ram imported at the same time. Eight other rams out of a flock of 32 pure-bred Merino rams also imported at that time were examined; one ram served for the first time in the 9th week after arrival, one in the 10th and four in the 11th week, and two had not served at all by the 11th week. At the end of the year there were still six rams out of this flock that would not serve. Two out of five Suffolk ewes came on heat in 7 months (September) and one in 9 months (November) after arrival in Kenya. The Suffolk ram served for the first time 6 months after arrival. Several of the recently imported Merino rams produced good sperm for a few weeks after beginning to serve, and then, more or less suddenly, sperm of poor or no motility.

Equine Pregnancy Diagnosis Test

A pregnancy diagnosis test for the mare based on the excretion of oestrone in the urine is carried out at the Experimental Station. Thirty-nine mares were tested during the year. In 19 pregnant mares and 10 non-pregnant mares the diagnosis was correct. For the other 10 mares confirmation has not yet been received.

Breeding Season of Ferrets in Kenya

In Britain the breeding season of ferrets lasts roughly from March–August and during the rest of the year the reproductive functions are in abeyance. In Kenya there is quite clearly an alteration in the time of the breeding season. All of the 6 female ferrets were on heat in October–December, and 3 of them also on heat in March and April.

General

Farmers' Days Meetings at Nanyuki, Nakuru, Eldoret and Kitale were attended by the Veterinary Research Officer, in November, and talks given on reproduction and sterility in live stock in Kenya.

Mr. Temple-Boreham, Stock Inspector, reported for duty on the 20th of November.

APPENDIX I

Live Stock

Bulls	7
Vasectomised Bulls	5
Grade Cows	69
Grade Heifers	89
Grade Calves	103
Grade Steers	4
Native Cows	13
Native Heifers	14
Native Calves	19
Work Oxen	54
Pure-bred Beef Cattle	9
Imported Merino Rams	11
Imported Merino Ewes	20
Pure-bred Merino Lambs	3
Grade Rams	9
Vasectomised Rams	11
Grade Merino Ewes	561
Grade Merino Hoggets	467
Grade Merino Lambs	306
Persian Rams	1
Persian Ewes	68
Persian Lambs	9
Masai Ewes	94
Masai Lambs	9
Pigs	42
Ponies	1
Donkeys	2
Total	2,000

APPENDIX II

FINANCIAL STATEMENT

Receipts			Amount
	Sh.	*cts.*	*Sh.* *cts.*
Balances on hand—			
Cash	159	01	
Bank	21,068	65	
			21,227 66
Live Stock			7,094 67
Butterfat			4,817 32
Wool			7,554 45
Sundries			383 65
Pregnancy Diagnosis Equine			180 00
Colonial Development Fund Grant			44,000 00
TOTAL .. *Sh.*			85,257 75
Payments			
Wages—			
Farm	5,602	04	
Laboratory	1,776	08	
			7,378 12
Foodstuffs			7,578 71
Freight and Transport—			
Farm	3,970	66	
Laboratory	2,689	81	
			6,660 47
Medicines and Instruments			298 86
Implements, Machinery, Buildings and Upkeep ..			4,607 40
Live Stock			12,180 19
Drugs and Apparatus			11,551 18
Staff Salaries			27,106 64
Sundries—			
Farm	1,190	63	
Laboratory	4,257	96	
			5,448 59
Balances on hand—			
Cash	25	92	
Bank	2,421	67	
			2,447 59
Total .. .. *Sh.*			85,752 75

APPENDIX III

RAINFALL RECORD

Month	1933	1934	1935	1936
	Inches	*Inches*	*Inches*	*Inches*
January	0·05	0·00	0·17	1·30
February	0·00	0·00	1·19	3·05
March	0·67	0·69	0·74	0·71
April	1·47	1·57	4·01	4·19
May	1·64	3·29	0·94	1·69
June	1·02	0·88	3·70	0·88
July	0·95	1·01	0·00	0·00
August	2·64	1·15	0·43	2·11
September	1·28	0·81	2·17	1·81
October	1·56	0·31	2·40	1·63
November	0·38	1·47	1·18	1·77
December	1·38	0·60	1·69	1·10
Total ..	13·04	11·78	18·62	20·24

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